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AMERICA'S NEED FOR THE NICARAGUA MARITIME CANAL.

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THE great problem encountered by commerce, always seeking solution, is how to bring producer and consumer into closer proximity; or, if this be impossible, how to bring to the lowest possible point the cost of transporting commodities under existing conditions. It is to the constant endeavor to solve this problem that we owe the extension of the railroad system through every portion of the United States.; because of it steam as a motive power both on land and sea is now the tireless and profitable servant of the merchant, miner, manufacturer, and agriculturist, and the great promoter of colonization, civilization, and growth of empire. It would seem that the solution of the problem in one direction has been attained,—that the minimum cost of transportation has, for the time being, been reached,—and that any further solution must be dependent upon diminution of distances.

The active competition for business, consequent at home upon the immense development of the railroad system of the United States and abroad upon the maritime enterprise of Great Britain, has resulted in freight rates lower by one-half or two-thirds than the actual cost of transportation twenty-five years ago. In 1865 the average rate for transportation of freight by rail in the United States was 3.451 cents per ton per mile, and the average cost of moving freight was estimated at 2.538 cents. In 1870 the rate paid per mile was 1.853 cents, and the cost 1.163 cents. In 1880 the rate paid per mile was 0.879 cents; the cost was 0.541 cents. In

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1881 the Pennsylvania Company reported the average cost per ton per mile, for freight moved, at 0.437 cents. There has since been no reduction in the average, though in the central tier of States through which our great trunk-lines pass somewhat lower rates have obtained. Actual cost may be roughly stated at ½ cent per ton per mile, under ordinarily favorable conditions. Ocean transportation has been estimated at one-fifth of railroad rates when moved by steam, or one-tenth when moved by sail. As a fact, ocean freights vary materially with every change of condition, and no definite ratio can be asserted, but practical experience affords data of value in determining conclusions. Between San Francisco and Europe, a long ocean voyage of 15,000 miles, which furnishes as good an illustration as can be asked, rates by sailing vessels fluctuate between $7.50 and $10 per ton. At these figures the rate per ton per mile is 0.05 to 0.068 cents per mile. At ordinary times wheat is carried from New York to Liverpool by steamer at 2½ pence per bushel, which is equal to about 0.066 cents per ton per mile.

Freights have been taken as low as 1 penny per bushel for wheat from New York to Liverpool or Havre, equal to 0.0266 cents per ton per mile; this rate is, however, abnormal and may even indicate some actual loss to the shipowners. It is a fact that goods can be transported in steam vessels from New York to Japan, the longest ocean voyage that can be named between points of production and consumption, at a less cost than by rail half-way across the United States. But the long ocean voyage involves loss of time to the merchant, to whom time actually is money. Loss of time involves direct loss of interest and also involves jeopardy to capital in different ways; it also involves higher rates of insurance. Whether the voyage is twice or three times as long as it might be determines the question whether the merchant shall make one, or two, or three profits upon the same capital within a given time. These reasons compel the payment by the merchant of the highest cost of transportation a commodity can bear, to secure the promptest delivery possible. These are the reasons which enable our transcontinental railways to collect from $20 to $30 per ton for carrying merchandise between New York and San Francisco, as against the $7.50 to $10 per ton which would remunerate ocean carriers between the same ports.

The construction of the Suez canal has secured to the commerce of Great Britain and southern Europe great advantages. Although,

less than half a century ago, Great Britain protested against its construction and hindered it by diplomatic interference, because of her apprehension that the canal would be detrimental to her commercial and military interests, yet she to-day is the largest owner of its shares, the greatest contributor to its revenues, and its greatest beneficiary. The annual report of the Suez Canal Company published on June 2, 1892, shows that of 4207 vessels which passed through the canal during the preceding year over 76 per cent. carried the British flag, while of the net tonnage transported, which amounted to 8,698,770 tons, 78 per cent. was British merchandise. A previous report shows that during the period from 1870, when the canal was opened to business, to 1887, the commerce of England with the Orient increased from $537,000,000 to $752,000,000, a gain of over 40 per cent. in seventeen years, while the increase of her commerce with the entire world, during the same time, was but 17 per cent. All this proves the rapid development of her Oriental commerce on account of the facilities offered by the canal. To the Suez canal must also be attributed the development of commercial undertakings which otherwise might have been wholly neglected. The increase of companies trading with East Africa may fairly come within this category.

But it is not only in the extension of existing commerce and the development of new that the influence of the canal has been felt. Its necessities and facilities together have undoubtedly been the cause of the rapid substitution of steam for sail as a motive power in ocean transportation. The canal has not only shortened the distance between ports, but practically compelled the substitution of a more rapid means of transport over the shortened route. The example of Suez is presented as an illustration of the effect upon commerce resulting from the increase of facilities for its transaction. Like results may be assumed wherever like premises exist.

The domestic commerce of the United States has been enormously developed by the facilities afforded in the extension of our railroad system through every portion of our broad domain. Our foreign commerce, however, has not had equal advantages. The opening of the Suez canal has afforded facilities to commerce, the value of which is indicated by the growth of its traffic from 436,609 tons in 1870 to 8,698,777 tons in 1891, but its benefits have accrued chiefly to Great Britain and southern Europe. Owing to our geographical position the participation of the United States in its advantages has been small. In a direct line westward we are as

near to Australia and China as Great Britain is by the Suez canal, and we are considerably nearer to Japan and to all intervening countries; yet, because of the southward projection of South America, our shortest practical route to those countries is through the Suez canal. From them we are further removed than all Europe by the breadth of the Atlantic Ocean.

Whatever we may possess of competitive advantages as regards the natural productions of our fields and mines is more or less negatived by this notable disadvantage of distance. And yet at one point on the Isthmus, which connects the two Americas, the canalization of a distance of only twenty-six-and-a-half miles, with a short cutting across a low divide elevated only forty-three feet above the lake level, and the utilization of existing natural waterways, will effectually remove the barrier which nature has hitherto interposed to the free westward movement of commerce. Its removal will also open up, in connection with the Suez canal, a maritime highway for circumnavigation of the globe in almost a direct line east and west. The actual circumference of the globe on a great circle is 21,600 nautical miles (about 25,000 statute miles). Before the opening of the Suez canal the practical route for circumnavigation, starting from New York, around Cape Good Hope to Hong Kong and home via Cape Horn, was 30,796 nautical miles. The opening of the Suez canal shortened this distance to 28,363 nautical miles. The opening of the Nicaragua canal will shorten the distance to 22,309 nautical miles, or 6054 miles less than the shortest route now existing,—via Suez. The following diagram, drawn to a scale of 8000 miles to the inch, is an illustration of the comparative distances:

Actual circumference of globe .....21,600 N miles.

Distance of circumnavigation before opening Suez canal.....30,796 N miles.

Circumnavigation via Suez canal. ....28,363 N miles.

Circumnavigation via Suez and Nicaragua canals..... ...22,309 N miles.

Natural obstacles forbid that there should be any other route so nearly direct as the location designated for the maritime canal of Nicaragua. It is necessarily the shortest possible navigable route

between many ocean ports now separated by intervening continents, and although the Suez canal must always be of greater importance to Europe, the advantages which the Nicaragua canal will afford to European trade with the Pacific coast of the American continents, and to points even as remote as New Zealand, would alone be sufficient to warrant its construction. But its chief and greatest advantage is to the commerce of the United States, in restoring to it the competitive equality which was destroyed by the opening of the Suez canal, and—even more than this—in giving to it material advantages of distance. Until the opening of the Suez canal New York was substantially as near to China and Japan as was Liverpool, but the opening of the Suez canal made Liverpool practically 2700 miles nearer than New York. With the opening of the Nicaragua canal, New York will be once more as near by available routes as Liverpool to China, nearer by 1000 miles to Australia, 2000 miles nearer to Japan, and 2700 miles nearer to the ports of the Pacific coasts of South America, which are now practically as near to Liverpool as they are to New York. The advantage of the Gulf ports of the United States over Liverpool or any European port will be greater by 700 miles than that of New York, inasmuch as they are that much nearer the eastern port of the canal.

The opening of the Nicaragua canal will provide a gateway and a direct route between the Atlantic and Pacific for the commerce of the world, but especially for the commerce of the United States. The wheat fleets which now annually take their long and stormy voyage around Cape Horn from California, Oregon, and Washington to the markets of Europe will find their route shortened by one-half the distance and exempt from more than one-half its perils, hardships, and discomforts. The same advantages, though in lesser proportion, will be realized by European trade with the Pacific ports of South America, with Australia, New Zealand, and with the islands of Australia and the Pacific ocean. The canal will make saving in distances traversed between ports, as regards Europe, of from 1000 to 8000 miles; as regards the eastern ports of the United States, from 3000 to 10,700.

President Hayes happily characterized it as "a part of the coast-line of the United States." That line now terminates on the Atlantic proper with the southern point of Florida, and recommences on the Pacific coast at the southwestern corner of the State of California. The distance between these points via the straits of Magellan, which at present is the shortest practicable route, is 12,500 miles (by sail-

ing vessel it is 15,000 miles), but by the Nicaragua canal it will be but 4250 miles.

But our commercial interest in the enterprise is that which most generally commends itself to consideration. With this thoroughfare opened the people of the Atlantic States of our Union will at once be brought into closer business relations with the 500,000,000 inhabitants of the countries whose shores are washed by the waters of the Pacific ocean, while the people of our Pacific States will be similarly benefited by a closer proximity to the markets of Europe. The trade of this 500,000,000 people is to-day almost monopolized by Europe. Our proportion of it is very small, as may readily be shown. China, Japan, Australia, Tasmania, New Zealand, Hawaii, Ecuador, Peru, Bolivia, and Chili have an aggregate commerce with the world as follows: Imports, $642,361,745; exports, $572,543,211; total, $1,215,004,956. In the distribution of this aggregate Great Britain and the United States participate as follows:

Imports from Great Britain and dependencies	$467,016,507
Imports from the United States	41,511,362
Exports to Great Britain and dependencies	346,550 882
Exports to United States	64,003,920

Thus while those countries buy less than 6½ per cent. of their supplies from us, our needs compel us to take and pay for nearly 11½ per cent. of the total amount of their surplus products; or, to put it in another and perhaps more significant manner:

Great Britain sells them goods to the value of	$467,016,507
And buys of them in return	346,550,882
Balance in favor of Great Britain	$120,465,625
The United States sells them goods to the value of	$41,511,362
And buys	64,003,920
Balance against the United States	$22,492,558

That this disparity would disappear if equal facilities for commercial intercourse were provided is apparent to the most casual observation.

The imports of all these countries are chiefly of textile goods,—largely of cotton, grown in our Southern States, bought of us by English merchants, and spun and woven in Great Britain,—and of manufactures of iron. In articles manufactured from both of these staples the United States will be easily first competitor for business when the Nicaragua canal shall afford us ready access to the markets from which we are now practically excluded by the cost

of the long and dangerous voyage around Cape Horn. In 1890 China, including Hong Kong, imported cotton and cotton goods to the value of $61,504,348, of which the United States supplied $5,360,508. Most of this business actually originates in the United States, as the raw material is grown here; its manufacture in Great Britain is an incident to the transaction which exists chiefly because of Great Britain's better facilities as a merchant.

What may be done, with transportation facilities in our favor, may be inferred by the fact that only $7,947,430 of the total importation was by the way of Hong Kong; the remainder went to the northern ports of China, to which the canal will make the cotton ports of the United States nearer than Great Britain by nearly 1000 miles, whereas she is now 2700 miles more remote; notwithstanding this disadvantage, the quality of its fiber gives American cotton the preference in Japan, where the manufacture of cotton cloth is rapidly growing into an important industry. In 1888 Japan bought of us 85,000 pounds of cotton (this was the first importation); in 1889 she took 95,000 pounds; in 1890 the shipments increased to 2,330,000 pounds; and in 1891 they amounted to 7,000,000 pounds. There are now 380,000 spindles in operation in the country. In Japan and China, with their dense population, there is a market for all our surplus cotton, and the progress already made by the Japanese cotton-spinners is assurance of still more rapid growth in the future, and of a steadily-increasing demand for the raw material. With the closer proximity to markets which the construction of the Nicaragua canal will give this country, the markets for manufactured cotton goods reached by the ocean routes of the Pacific will be open to us.

The reasons which at present prevent our participation in this trade are equally operative with regard to manufactured iron, and the advantages to accrue from removal of these obstacles are equally available. Japan and China have as yet only commenced the construction of railroads. China is traversed in all directions by ordinary roads and has many canals and navigable rivers over which a large internal trade is carried on, but is almost without railroads. Telegraph lines are being rapidly extended all over the kingdom, and railroad construction will soon follow. Japan is more enterprising, and has already 1128 miles of railways and about 7000 miles of telegraphs. In 1875 there were in India but 6519 miles of railways. To-day there are 16,996 miles, and it is not unreasonable to expect that the spirit of enterprise and advancement, which

has been awakened in China and Japan, will soon follow the lead of neighboring India.

The value of iron and steel manufactures imported in 1890 by the countries named, bordering on the Pacific, amounted to $28,250,000, of which the United States furnished only $3,500,000, a large proportion of which was for locomotives, stationary engines, and machinery of every description in the manufacture of which we excel. That these countries have taken from us what their necessities demand is evidence that their markets are open to us for such commodities as we can supply advantageously; that they have taken so little only shows that we are embarrassed by disadvantages which prevent an equal competition for the business which they have to bestow. The construction of the canal will, as has already been shown, not merely give us this equality in the more remote of these markets, but, in many of them nearer by, it will give us the advantages of proximity now possessed by Europe. And this competitive advantage will affect not only the iron and cotton trade, but every industry that produces its own specialty beyond the needs for home consumption. Among other things it will afford a large market for the coal of our Southern States.

The advantages of the canal to the Pacific States of our Union have already been briefly adverted to. Mr. B. F. Fernow, chief of the Forestry Bureau at Washington, estimates that in the Pacific northwest there are 25,000,000 acres of timberland, capable of supplying 400 billion feet of lumber. This timber is to-day worth from 50 cents to $1.50 per 1000 feet on the stump. Timber of like quality in Minnesota, within transportable reach of a market, is worth $6.25 per 1000 feet stumpage. Freight on timber from Puget Sound to New York or Liverpool is to-day $12 to $14 per 1000 feet. The shortening of the distance by the construction of the canal would make, canal toll included, a rate of $9 per 1000 feet more remunerative to the ship-owners than $12 around the Horn. This $3 of freight saved is value added to the timber on the stump, and would be so much advance on the present price of 50 cents or $1; or, assuming that the owner gets only one-half of the saving, that is to say, an increase of $1.50 per 1000 feet, the value thus added to the standing timber of the Pacific northwest would be $600,000,000 realizable by the lumbermen. In 1891 the Pacific coast shipped 1,800,000 tons of wheat and flour to Europe and Atlantic ports. The construction of the canal would permit of a reduction of $2 per ton on such freight, with better returns to the

ship-owner than from present rates. Such a saving of freight would mean an advantage of $3,600,000 on the crop of the year, for the benefit of the wheat grower or shipper. And what is true of lumber and wheat is proportionately true of every other product of the country, such as fruit, wool, hops, and wine.

Reduction of freights upon exports involves of course a like reduction upon imports, and while the one means higher prices for surplus products, the other means lower prices for every commodity imported from Atlantic ports, whether home or foreign, for domestic use or consumption. Such advantages to the colonist, together with favorable climate and low-priced land, cannot fail to attract a well-nigh unprecedented tide of immigration to the Pacific slope, as soon as the canal is available for use.

To European commerce the event of the completion of the Nicaragua canal would be merely one of increased economies and further gains. To the United States it is of far greater importance. At the close of the war of independence the population of the city of New York was less than 24,000. But little more than a century has passed away and New York, with Brooklyn and Jersey City, which are as much a portion of New York as Southwark is of London, has a population of 2,800,000, second only to that of London. This remarkable growth both of city and nation is traceable to unprecedented natural advantages and to the enterprise of our people. But Europe, by opening an ocean route across the isthmus of Suez, has gained an advantage over earlier conditions to which natural advantages and energy of character are not an adequate offset. The equilibrium under which this growth was made has been disturbed by the construction of the Suez canal in the East, and can only be restored by the construction of the Nicaragua canal in the west. This new construction may, and probably will, permanently overbalance the scale as much in favor of America as it is now turned in favor of Europe.

Until the Nicaragua canal is opened, America must continue almost all her intercourse with the peoples of the Pacific ocean under the conditions of the past, while Europe, profiting by the Suez canal, stands between us and them, the first to offer in their markets commodities which both of us produce in excess of our needs, but which we, because of our remoteness, cannot supply as soon or as cheap as Europe.

THE RELATION BETWEEN THE ENGINEER AND THE ARCHITECT.

By George Hill, M. Am. Soc. M. E.

IN a proper sense, the term "architect" should designate a man of certain attainments, but in deference to a popular prejudice it is applied in the following to an artist who designs and superintends the erection of buildings, although it will be admitted, after due consideration, that our best architects are quite often as good engineers as they are artists, and that sometimes they are preëminently good business men.

The first and most evident of their relations is the jealousy between them which should not exist, considering how intimately the work of the two professions is interwoven. Yet we find on the one hand an engineer of considerable experience complaining of the architect's treatment of "the man who does the practical work,"* while on the other hand a great many architects do not employ a man of proper training and experience to do their engineering work, claiming that there is not enough of such work to require it, or else that they find the engineer impracticable or intractable.

There is no doubt that, if the engineers were perfect, they could find fault with good grace with the artistic architect for the impracticable way in which he sometimes plays with the interests of his clients, promising drawings and results for dates weeks in advance of what is possible; and the architect could, with as much reason, criticise the way in which the engineer serenely erects the most hideous structures simply because he fancies that he can in this way save to the owner a few pounds of metal or a few dollars of cost. These are extreme cases, and they are each day becoming rarer, but they serve to explain why the feeling of jealousy exists, since each feels that the other is guilty of a sin that is unpardonable, while his own is not so very bad, all things considered.

The ideal requirement is that all of the various qualities of good artist, good engineer, and good business man should be combined in

* See Mr. Porter's paper on "How Can we Improve the Status of the Engineering Profession?" read at the late annual meeting of the American Society of Mechanical Engineers.

one man, who would be qualified to give each branch its proper weight in the solution of any problem. In practice this is generally impossible of attainment because of the widely-varying temperament and training needed for the best results, and we must therefore look to a combination of these three elements in at least two individuals, working together in each architectural combination that is to meet the implied obligation assumed by every professional man when he solicits the patronage of his fellows, to render a service at least as good as the average and, in some particular, better. We should then have the various problems that each commission contains carefully studied by specialists, and the final result would represent that happy mean that is the best for the case.

The writer has had considerable experience in this line, and feels that the cause of much of the friction is due to the lack of proper training of the engineers for this particular work, due largely to the newness of the demand.

Instead of the feeling that once existed that the architect should know at least all that the "Encyclopedia Britannica" contained, people nowadays are differentiating and do not expect so much of practical things from the artist, but in many cases transfer to the business or practical man a part of this requirement of mechanical or engineering knowledge, and welcome the services of the expert whenever they are rightly needed.

The requirements of the "domestic" or architects' engineer are certainly great, since he must have on tap at all times information of the best usual practice in regard to character and resistance of materials, including earths, stones, bricks, clays, woods, metals, cements, plasters, glass, paints, papers, wools and other textile fabrics, and methods of manufacturing and working these materials; heating by hot air, hot water, or steam; ventilation, steam cooking, gas and electric power and lighting, steam-power plants, plumbing, water-supply, and sewage-disposal, and the laws relating to contracts. He must also be sufficiently trained in mechanical engineering to be able to appreciate the requirements of almost any manufacture or business so as to be able to make plans for the case in question at least as good as the average, or a little better. His experience in these branches must be such that, while the first studies are being made, he can formulate the requirements in such a way as to determine the approximate limits of the space required for each of the mechanical features, so that space can be allowed for them at the beginning which will be sufficient for

his needs when the time comes to take them up, perhaps months after the plans are drawn and the work begun. He must know enough of art to appreciate its limitations, so that his suggestions of what must be done to accomplish economical, buildable results may be permissible from the artistic point of view. He must also know that a given lay-out of the framing will be within a small percentage of the most economical that can be made for the given case, so that his assistants can be kept at work on the detailed computations, thus keeping pace with the balance of the work. In the actual execution of work he should be able to do anything that is needed on a building, although perhaps not in the expeditious way that can be gained only by long practice. Finally, he should know that in each of these varied branches his knowledge must be in a measure superficial, and that there are men in each branch who know more than himself, who should be called to his aid when the interests of his client demand expert advice.

To obtain such knowledge as is here outlined it is necessary that a man be thoroughly trained in some good technical school, preferably mechanical, and that his mathematical training be of the most thorough kind,—not that he will ever need anything higher than trigonometry, but that the analytical habit that comes from a thorough mathematical training may be acquired. He should be able to converse readily in both French and German, and should attend a few lectures in architecture, or read a few good architectural works to get an idea of first principles. Finally, he should be a careful reader of the technical journals.

On graduation he should begin the acquisition of experience, going from one job to another, staying in one place only long enough to get the more evident of the fine points involved, and then on to another until he has done work in each branch. He should join the technical societies in the junior grades for the further carrying out of this purpose. During this period he will have rubbed against many men and should have learned to make himself agreeable to all; he will have formed many acquaintances and heard many practical talks. Finally, he should trace for a time in an architect's office, and when he thinks he has become sufficiently posted to be able to write a good specification, evolve one from his inner consciousness and compare it with one written by a competent man, to see how many things he has left out, and how much he still has to learn. Then he should finish off as the assistant of some good domestic engineer for six months or a year. If the

material is in him, he will then be able to stand alone in responsible charge of work. He should have learned to control his temper at all times and under all conditions and never to announce a decision until it has been carefully studied, and then not to change it until at least twice as much time has been given to it as was given originally.

It might be well if he could try his hand at architecture in a small way so as to learn practically how great are the annoyances and how many the details that have to be looked after. This would make him appreciate better the trials of the artist.

The architect, on the other hand, requires a thorough training to fit him for the proper discharge of his duties. These are not only the drawing of a pretty picture, but the building of a substantial, handsome, and economical building that will meet all the requirements of its use, and that will be erected at a reasonable cost and in a reasonable time. He must also be sufficiently posted in construction, so that during the period of small things he will be able to do fairly good construction and know when his knowledge is at an end and an expert's knowledge is desirable, or necessary. He must not lose sight of the art in his work, as this is of prime importance, and he must therefore spend his time principally in improvement in this line. Habits of exact thought, logical reasoning, and concentrated effort should be acquired, and he should be especially drilled to a realization of the necessity of regarding all commissions in their true relative importance. This ground has been well covered in a paper* by Professor Ware, of Columbia College, which affords an excellent basis on which to start a discussion of what the architect should be taught. So instructed, the architect would be prepared to regard the engineer more as a co-laborer than as a necessary evil, thus making their relations of a pleasanter nature.

Having now determined the knowledge that the architect and the engineer should each have, it remains to so apply it that the result of their joint labors shall be the best possible under any given conditions, for it must be borne in mind that there was never yet a problem in architecture capable of a solution that was, in every particular, the very best possible. There must always be something that could be better were it not for something else that must be considered.

We are accustomed to think that, when the architect is the prin-

* *School of Mines Quarterly*, November, 1888.

cipal in a building in which the constructive features compose at least 75 per cent. of the work, it is a case of "the tail wagging the dog." But if we should examine the work of some man who so believes, being accompanied by a good critic, we will find in every part of the work evidences of that neglect of proportion that makes all the difference between a good job and a botch. The writer knows of instances where many thousands of dollars were spent after the building of a house, to get it into better proportion.

There is also the other extreme, in which the architect sacrifices everything else for a certain effect that could have been obtained in a different way at a saving of many thousands of dollars to the client. Each of these cases really only illustrates our human weaknesses and shows how necessary it is that there should be two minds of differing characteristics, examining each problem to insure against such blunders. Then we should have each one doing that share of the work that he was best fitted for, which in practice might reduce itself to this procedure:

When a client intrusted a commission to an architect, he would first confer with the business man,—practical man, or engineer, or whatever else he may be called,—discussing the entire problem. Then the business man would discuss it with the artist, thus acting as the interpreter or intermediary between the very practical client and the artist. When the preliminary studies were completed, they would see the client together to discuss them, thus saving a lot of unnecessary study, work, and talk, effecting a considerable saving of time and minimizing the likelihood of blunders. If the client were more artistic than businesslike, then the procedure might be reversed; the artist being consulted before the business man.

This method is advised because all good architecture must be the result of a course of reasoning,—the requirements of the work and the limitations of the site giving the plan, the plan speaking or outlining the elevations, and the character of the elevations fixing the detail. It is true that a building for a given purpose may be designed in a dozen different ways, but that difference will be like the difference between the individuals of a family rather than that between individuals of different families. It is necessary therefore that the requirements should be determined as exactly as possible to enable the artist to study his plan intelligently, and for this purpose the engineer's training should better fit him.* The

*The writer's articles on "The Management of an Architect's Office" in *The American Architect*, No. 816 *et seq.*, go more fully into the detail of this.

writer's experience makes him sanguine that the harmonious working of the two interests in some such way as is here outlined will soon become quite general, to the great advantage of the artist, the engineer, and the general public.

The general public is also deeply interested in this question, since the buildings that such a combination would design and erect would be a decided advance on the usual thing. This is self-evident, when it is stated, but it is rarely permitted to influence the choice of an architect, who is oftener selected because he is a good fellow, or a good artist, or is fashionable, or has the vogue, but not because his office force embraces a specialist for the solution of each of the problems, or because it is organized so as to handle everything in a strictly business way. Of course we do reap a benefit from all of this in the friends that it is bound to make for us, but this is only because the results are satisfactory, and if the client should be of such a peculiar nature as to be constantly obstructing, then the results would not be so good, and the friction that would result in getting anything like a satisfactory result would make the client complain of a particularly good piece of work as much as if it were badly done.

If clients would recognize that the architect's best work is always done when in competition with himself, that the best man or firm for them to employ is that one whose work in its general character is most pleasing to them, and whose methods are such as to give the most satisfactory results, there would be far less trouble in the end, and the results would be buildings better adapted for their requirements. This would especially be productive of better results than the method for the choice of an architect outlined by Mr. Bernard McEvoy in the January number of this Magazine. While this subject could better be treated in a separate article, still it seems appropriate to call attention to some of the more evident of the objections to Mr. McEvoy's plan of competition for selecting an architect.

First, the demand for detail in the study of the plans for the purpose of making the heating, sanitary, and ventilation arrangements of any value, is such as to result in its exclusion from any terms of competition that a well-equipped architect would enter into unless he were well paid. With the terms thus modified the work could be competed for by any office-boy who could handle a pencil, and this would result in the exclusion of the good men. Their demand for details to a $\frac{1}{2}$-inch scale means nothing, since the

scale is too small to be of any value for any purpose, and would only add work that would have to be done over again when the work was actually begun. Finally such complete plans, assuming that they were drawn in good faith, without the expectation of any further study,—a condition that would be impossible of fulfillment in any good office,—would be still of no use, since there would be surely some detail that would be susceptible of improvement after Mr. McEvoy's committee and the architect had conferred together. It is the writer's belief that competitions are absolutely wrong in principle, that they are as much out of place in architecture as they would be in medicine, and that every architect should do his best to discourage them unless they could be so managed as to occupy a position analogous to that of a consultation of physicians.

After all, the results that we hope for must be the fruition of a growth of public sentiment having its birth among the professional men, then spreading through the medium of the technical press and technical societies until the end is attained. That our ideal is possible of accomplishment is certain, since we ask for no more than is accorded freely to the other professions, except in matters that we are remedying of our own volition. When this is done, when artist and engineer labor harmoniously for the one end, forgetting everything but the result aimed at, and are intelligently seconded by the client, we will repeat in every city in the land, in a small scale, the splendid achievement of the White City on the shores of Lake Michigan.

SHIP-BUILDING ON THE GREAT LAKES.

By Henry A. Griffin.

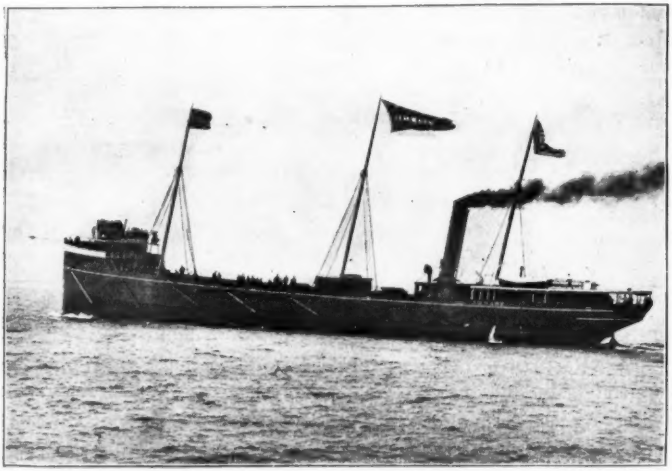
THE evolution of commerce on the Great Lakes, with their 270,000 square miles of surface and 3000 miles of United States coast-line, has exhibited some interesting transformations and wrought some momentous changes in the past forty years. This period has witnessed the rise and the fall to an inferior place of a great sailing marine, and the fall and subsequent rise to first importance of the passenger transportation business. No longer ago than twenty years the great bulk of the freight carried over the lake routes was conveyed in sailing-vessels, mostly of small tonnage,—from 200 to 500 tons,—though a considerable number of from 800 to 1000 tons burden imparted dignity to the processions constantly moving east and west during the navigation season. Up to that period,—the beginning of a new era in the history of the lake-marine,—the Detroit river, through which all the transportation lines of the upper lakes pass, often presented a scene that for marine picturesqueness could not be equaled elsewhere on the earth.

It was just before the practice of towing through from Amherstburg to Port Huron became general. A stiff northerly wind, blowing continuously for two or three days, making progress up-river against wind and current impracticable for sailing-vessels, not infrequently caused the gathering of a fleet of 100 to 200 white-winged craft at the head of Lake Erie. Then, at the first impulse of a favoring breeze, they would up-sails and away all together, crowding the channel of the Detroit river to its full capacity. There would be stately brigs and two- and three-masted schooners, interspersed with the "mosquito fleet,"—the stone- and lime- and wood-carriers of the river routes,—taking the wind out of each other's sails so that the best sailers had little advantage in the race. The whole mass, compact and beautiful, and reaching for miles, moved slowly forward with the wind but against the tide, creating a marine picture of vivid interest never to be forgotten.

But the exigencies of traffic began to require quicker time and larger hulls. Towing through from Lake Erie to Lake Huron became practically universal, so that the lake-carriers were no longer

assembled in great fleets by adverse winds, but passed up and down the rivers regardless of the force or direction of the breezes; and wrecked and decaying sail-vessels were supplanted by great steam-barges with consorts in tow. There are many fine sailing-craft still upon the lakes, and occasionally a new one is launched; but by far the greater part of new tonnage is propelled by steam, and the day of the sailing-vessel on the lakes is rapidly passing.

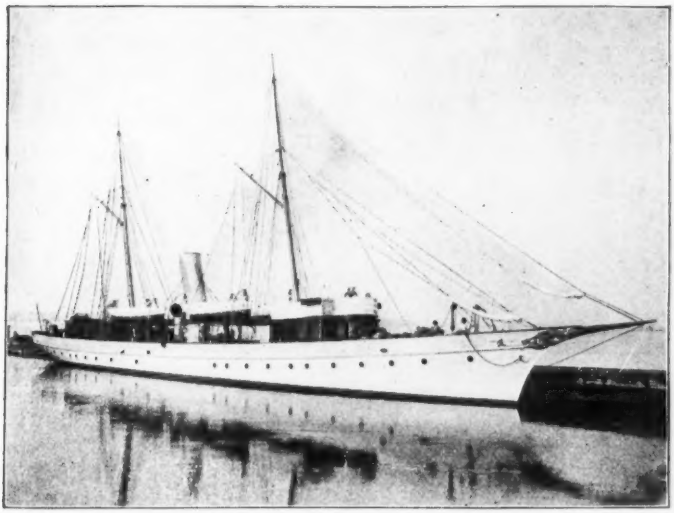
Back in the "forties" and "fifties," before the days of through trunk lines and cheap railway transportation, the march of empire westward was largely dependent upon lake passenger-steamers. Fine, large sidewheel steamships plied between Buffalo and the



THE "J. H. WADE"—CLEVELAND SHIP BUILDING COMPANY.

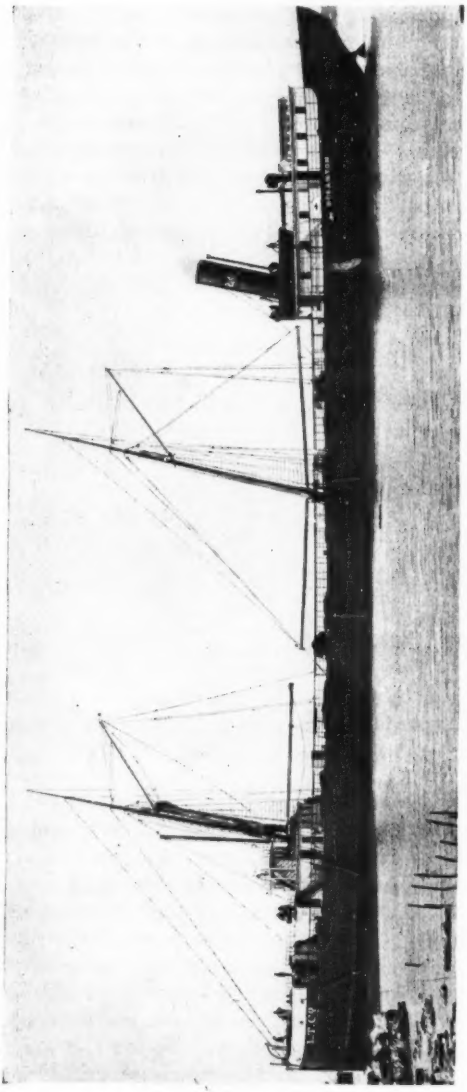
western ports of Monroe, Detroit, and Chicago, loaded down to the gunwales with passengers and household effects, bound for the free lands of Michigan, Illinois, Wisconsin, and Minnesota. Railway development drove this traffic from the lakes, and absorbed it. A few river and lake-shore passenger lines have been constantly maintained, and a few routes like those between Cleveland and Detroit, and Milwaukee and Grand Haven, owing to peculiar conditions, have employed a class of large and well-equipped passenger steamers up to this time. But through passenger travel on the lakes was virtually abandoned for many years, and its imminent revival is a significant feature of any narrative of the lake-marine.

This revival has been hinted at for years past in the unsatisfied applications, increasing rapidly in number for several seasons, for through and round-trip passages over the 1200-mile waterway of the upper lakes; and also in the enlarged cabin capacity and improved bills of fare on the large freighters constructed in recent years, prepared for the accommodation of owners and their friends. The freight-steamers may not carry passengers; but there is no limit to the number of the crews and employés. Under this condition it has been practicable for many people eminent in politics, in business, and in society, to ship as



STEAM-YACHT "WADENA.
[Owned by J. H. Wade, Jr. Has crossed the Atlantic twice.]

"deck-hands," "assistant clerks," "stewardesses," and "chamber-maids," but whose names have not appeared on the pay-rolls and whose servitude would never be suspected by one not having access to the ship's list. This pleasing fiction of duty "before the mast" has given zest to the voyage of many a party of wealthy excursionists. But it has afforded no satisfaction to the great and growing class of well-to-do Americans who begin to appreciate the beauties and healthfulness of the inland seas, and are able and willing to pay for first-class steamship accommodations. The constant pressure therefore resulted, first, in rumors of new lines of fine passen-

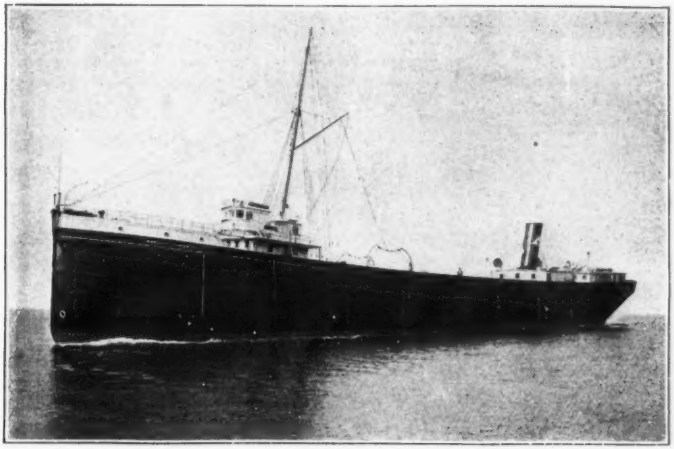


THE "SCRANTON."—CLEVELAND SHIP-BUILDING COMPANY.

ger steamers, and, latterly, in the investment of large amounts of capital for the realization of these rumors.

Immigration from Europe and migration from the stony hillsides of New England to the gently-rolling, stoneless prairies of the West, created a great passenger traffic a generation ago. The growth of great cities on the lakes, the development of the country adjacent and tributary to the lake system, and the annual northward flight of prosperous thousands from the section south of the Ohio river, are combining to re-create that traffic on a far grander scale. Fifteen millions of people now live upon the shore lines of the

lakes, or within six hours' travel by rail, and nearly all of that population is south of the United States boundary line. The territory directly tributary to the lakes, north and south of the line, is capable of easily maintaining a population of 100,000,000. In view of our own assured national growth, and the possible annexation of the Dominion of Canada, it does not require a very lively imagination to foresee the Great Lakes surrounded by the most prosperous and progressive people on earth, and crossed and recrossed by scores of lines of passenger steamships in addition to a still greater number of freight-lines. The responsiveness of capital of late to the demand for first-class passenger-steamers, a



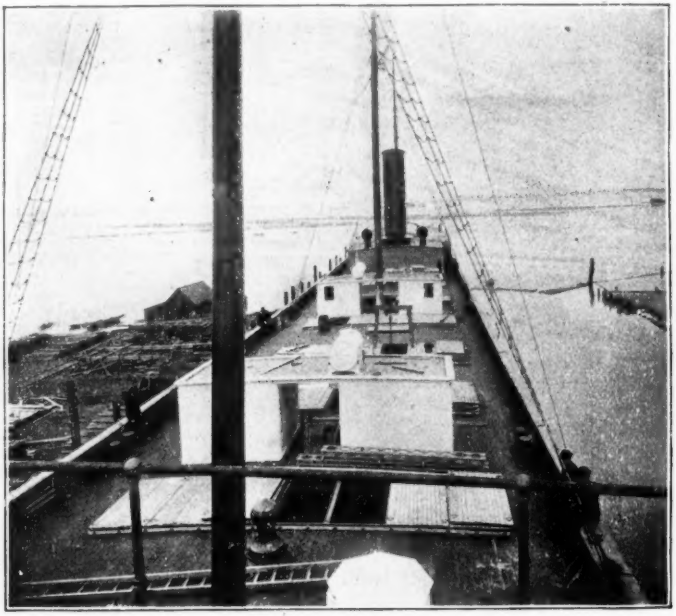
THE STEAMSHIP "MANOLA."
[Owned by the Minnesota Steamship Company.]

number of which are already launched or on the stocks, is an indication that the revival of passenger traffic will not lag or be delayed for want of means to realize its utmost possibilities.

In the days of high freight rates vessels of 200 to 800 tons could profitably transport grain, ores, and lumber eastward, and coal and merchandise to the West. In 1860 it cost 15 cents a bushel to carry grain from Chicago to Buffalo by water. Ten years later the cost had been reduced one-half; and in 1891 it was only 2½ cents. In 1867 the average freight rate on ore from Escanaba to Lake Erie ports was $4.25 a ton; in 1870 it was only $2.50; and in 1891 it had fallen to 84 cents. In 1891 coal was

carried from Cleveland to Duluth, nearly 1000 miles, as low as 40 cents a ton, which is the minimum charge for delivering a ton from a local yard to a city consumer!

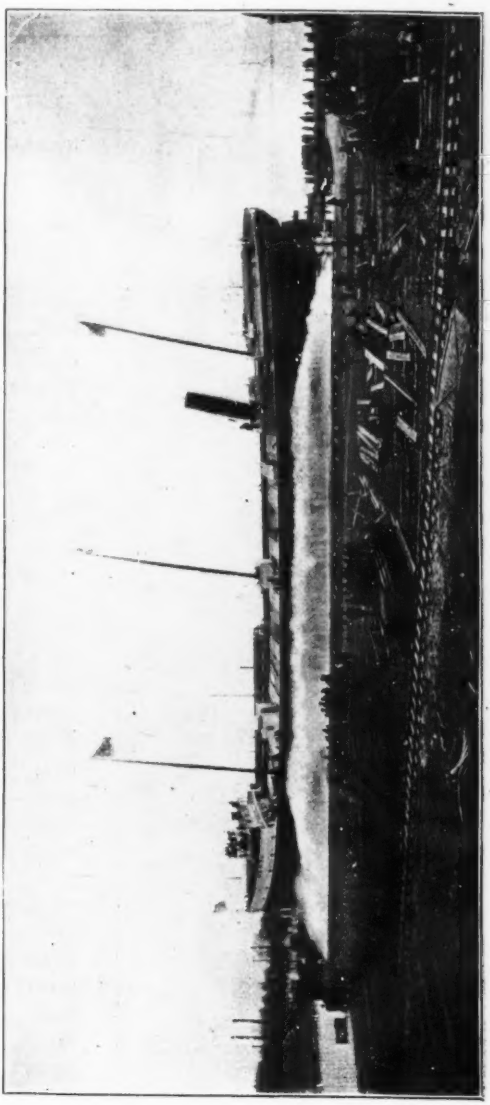
Large and profitable production and transportation of grain, ore, lumber, and coal demanded large reductions in freight charges. The tow-barge lines ineffectively aimed to satisfy the demand. The average tonnage of registered freight vessels, which was about 500 tons in 1870, began to increase, and last year it was 884 tons. The draught of vessels, owing to shoals in the rivers and bars at harbor



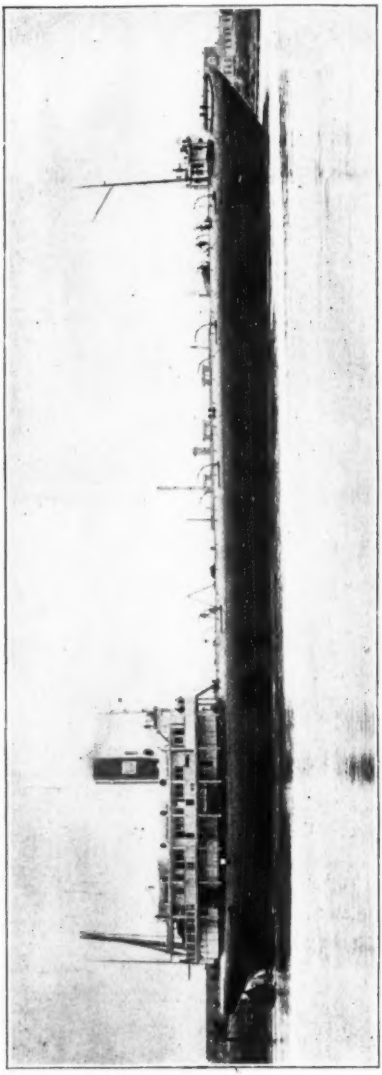
STEAMER "MAHONING"—A VIEW FROM ALOFT.

entrances, was limited to 15½ feet. The conditions of traffic demanded the construction of vessels of the largest carrying capacity on 15½ feet draught. The limit was so crowded by ship-builders and ship-owners that the grounding of vessels became too frequent for profit and safety; and Congress was urged, in the end successfully, to greater activity in improving the shallow passages and harbors. The zenith of the wooden ship on the lakes, sail or steam, was reached. Owing to the great weight of a wooden vessel,

the limit of 2000 tons could not be passed on 15½ feet of water—on any safe or profitable lines of construction. Then dawned the iron age of the lake marine; for iron ships of safe construction can be built to carry 3200 gross tons of freight on 15½ feet of water. The wooden ship-yards are therefore becoming obsolete. The raw materials for the freighters and passenger steamships are no longer hewn out of the forests, but are blasted out of the mines of ore and coal. The effect of the transformation from wood to metal on the growth of ship-building and traffic is easily computed. But no one has ever attempted to calculate the hun-



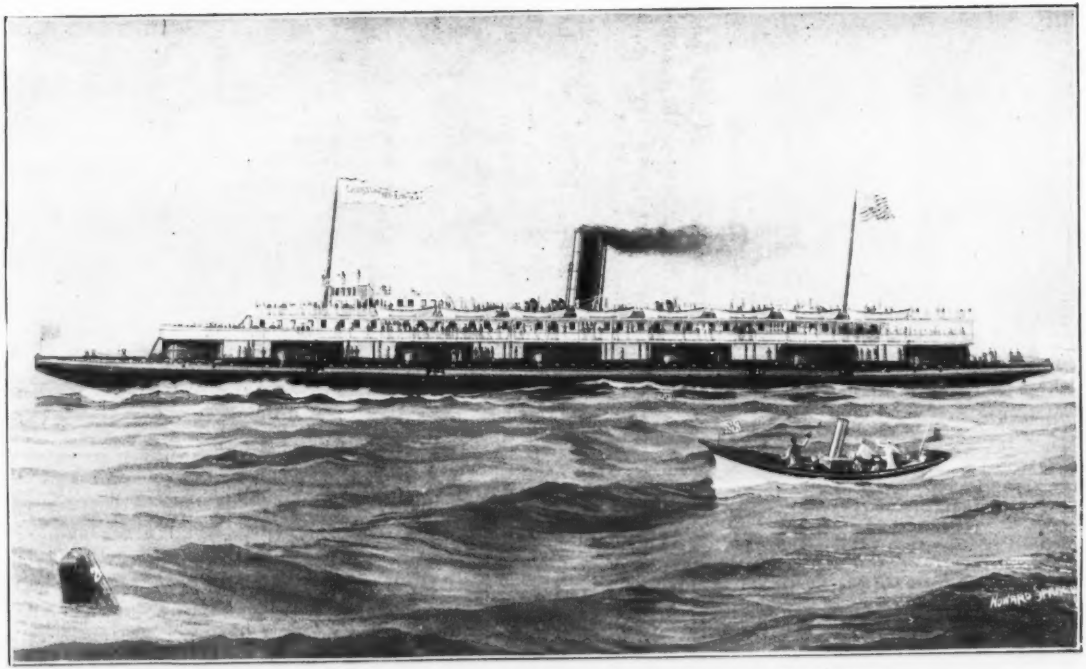
LAUNCH OF STEAMER "MAHONING."—DETROIT DRY-DOCK COMPANY.



THE M'DOUGALL WHALEBACK.

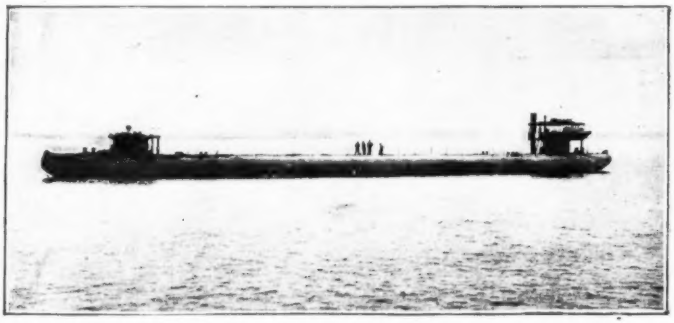
dreds of millions of dollars that have been saved to the people of the United States and Europe by the revolution in freight rates effected by the change. It has been as potent in its influence upon rates by rail as upon rates by water.

The ship-builders of the lakes readily adapted themselves to the changed conditions, the leaders of the industry promptly converting their establishments into producers of iron vessels. In 1872 the iron ship-building industry was fully domesticated at Cleveland and Detroit. Iron vessels had been built experimentally and were afloat before that time, but the comparatively high price of iron—it was before the days of cheap steel—had restrained enterprise from much exploiting in that direction. The turning-point was fairly reached in 1872. The Detroit Dry-Dock Company purchased a plant at Wyandotte, a suburban town with large rolling-mills, in 1879, and they have turned out scores of splendid steamships. The



WHALEBACK STEAMER "CHRISTOPHER COLUMBUS," TO CARRY PASSENGERS TO THE WORLD'S FAIR.

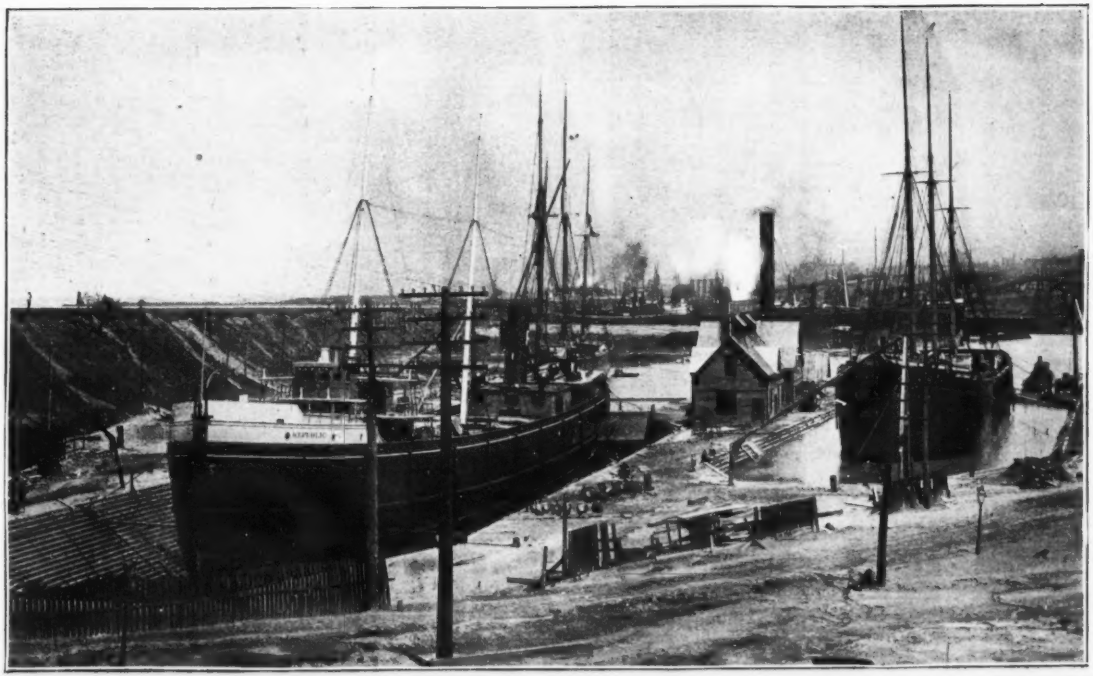
[Built by the American Steel-Barge Company, West Superior, Wisconsin.]



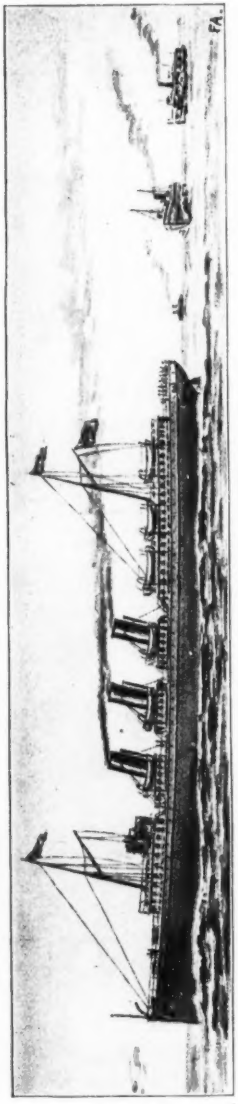
WHALEBACK STEAMER NO. 85.
[Built by the American Steel Barge Company, West Superior, Wisconsin.]

Cleveland firms whose work is pictured in these pages made quick response to the new demand; Buffalo and Milwaukee followed with somewhat feebler energy; Chicago halted until very recently, but is at last awake to the opportunities presented in this line; West Superior, Wisconsin, within a year or two has challenged her older competitors in the amount of new steel tonnage; West Bay City has become one of the foremost ship-building cities on the lakes; and other localities have made a good showing.

GEORGE T. BAKER'S SUBMARINE BOAT.
[Built at Detroit, to carry torpedo, in competition for the United States Navy Department prize.]



SHIP-OWNERS' DRY-DOCK COMPANY'S DOCKS, CLEVELAND, OHIO.



SKETCH OF A TWIN-SCREW PASSENGER STEAMER.
[Building for the Northern Steamship Company by the Globe Iron Works.]

The annual average of new construction during the past three years has been a little over 100,000 gross tons, mainly iron and steel steamers; and the new vessels are of the largest class, 2000 to 3000 tons each of carrying capacity. On January 1, 1893, there were fifty one vessels under construction or contract, averaging over 2000 tons carrying capacity each, whose total estimated cost is $6,900,000, or about $70 a ton. From this it will be seen that new tonnage to the annual value of about $7,000,000 has been constructed in recent years, and the total for 1893, it is expected, will largely exceed these figures.* The tonnage which passed out of existence during the past year through total loss by shipwreck and fire, and excluding partial losses, was 28,708 gross tons, valued at $1,014,250. On June 30, 1891, there were 1592 steam-vessels, aggregating 736,751 gross tons, and 2008 sailing and unrigged tow-vessels, aggregating 418,119 gross tons, plying on the Northern lakes, or

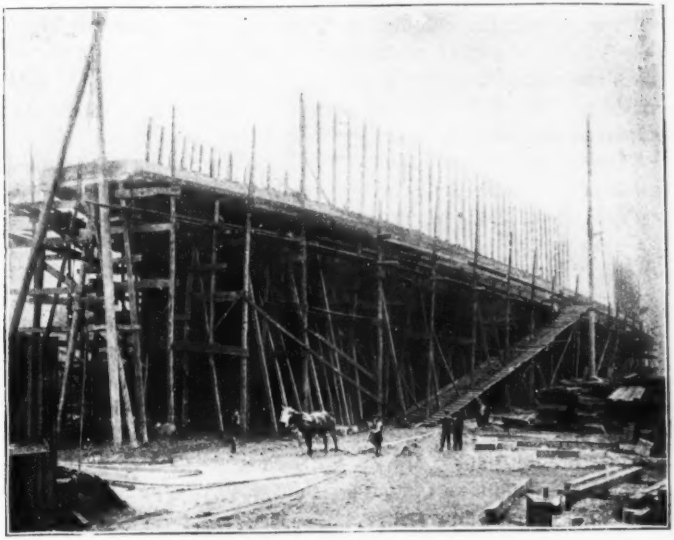
*Reports and estimates of tonnage sometimes appear to conflict with each other. This is generally due to the fact that there are three kinds of tonnage, "gross," "net," and actual carrying capacity. Gross tonnage is computed upon the measurement of the entire carrying space. Net tonnage is the gross tonnage less the space devoted to machinery. The actual carrying capacity is greater than either, as a rule. The tonnage of the steamship *Manola*, for illustration, is as follows: Gross, 2326 tons; net, 1836; carrying capacity, estimated on 15½ feet draught, 2800 tons. Some reports used as a basis of calculation adopt one of these kinds of tonnage and others another kind, so that it is practically impossible to make the figures precisely agree with each other in all cases. It is well to note, also, that a ton of coarse freight is 2240 pounds; and that a vessel carrying 3200 tons of iron ore has a load of nearly 3600 net tons of 2000 pounds to the ton.

a total of 1,154,870 tons. The value of this fleet is estimated at $70,000,000. In the five years ending with 1891 the tonnage increased 37.24 per cent. and the value 86.47 per cent!. The increase was substantially all in iron and steel vessels. An instructive comparison of the merchant marine of the lakes with that of the Atlantic, Pacific, and Gulf coasts and the Western rivers is afforded by this table:

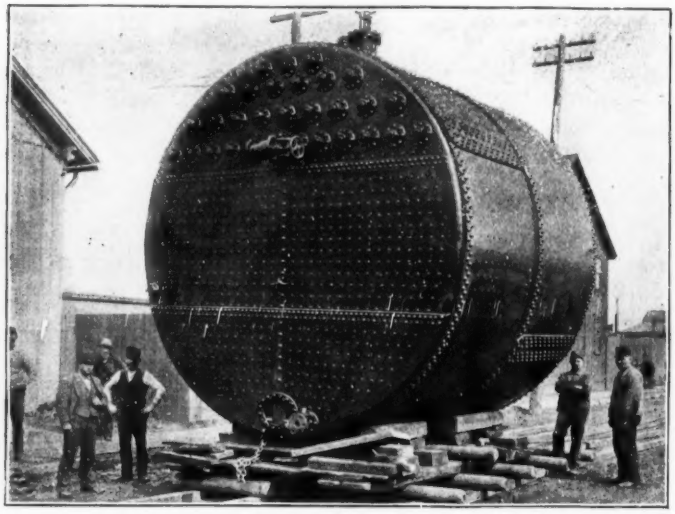
MERCHANT MARINE OF THE UNITED STATES ON JUNE 30, 1891.
[From the report of United States Commissioner of Navigation.]

Districts.	Steam Vessels.		Sail and Unrigged.		Total All Classes.	
	No.	Gross Tons.	No.	Gross Tons.	No.	Gross Tons.
Northern Lakes.....	1,592	736,751.53	2,008	418,118.85	3,600	1,154,870.38
Atlantic & Gulf Coast	2,935	886,375 34	14,629	1,894,307.93	17,564	2,780,683.27
Pacific Coast.....	578	187,429.26	880	253,428.48	1,458	440,357.74
Western Rivers.....	1,111	205,707.69	166	102,639 86	1,277	308,347.55
Total	6,210	2,016,263.82	17,683	2,688,495.12	23,899	4,684,758.94

The average size of the vessels of the lake marine is thus shown to be twice as great as that of the ocean merchant marine. The tonnage of the lakes is now nearly 36 per cent. of the total of the



STEAMER NOW BUILDING FOR FERRYING CARS ON THE STRAITS OF MACKINAW.



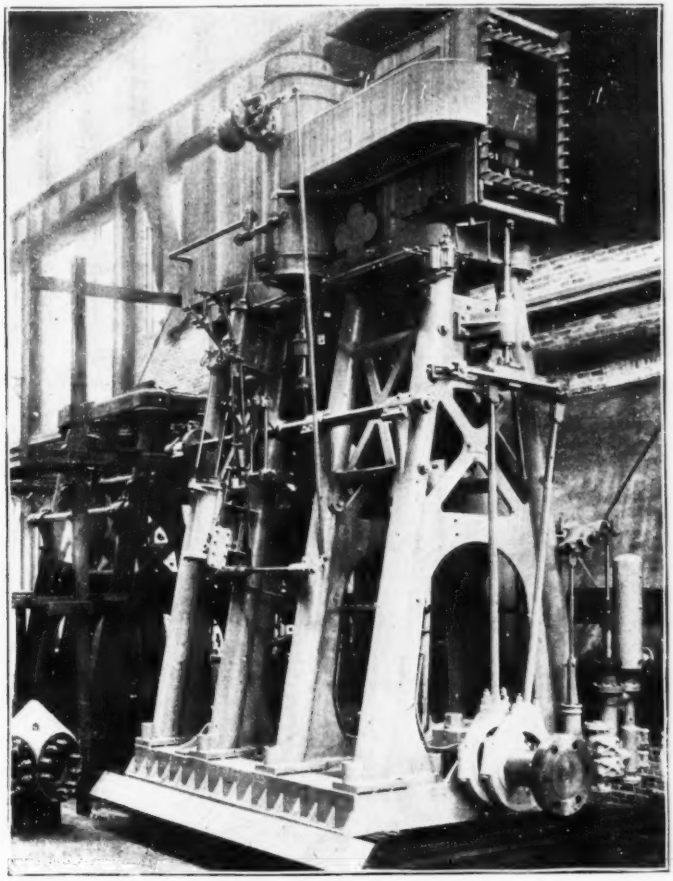
BOILER FOR THE "SELWYN EDDY"—DETROIT DRY-DOCK COMPANY.

merchant marine of the United States, excluding that of the Western rivers. During the five years ending with 1891 the steam vessels built upon the lakes aggregated 407,695 tons, while the total of the same class of vessels for the Atlantic, Pacific, and Gulf coasts and Western rivers was 237,787 tons. Over 40,000 men are employed upon the vessels of the lake marine.

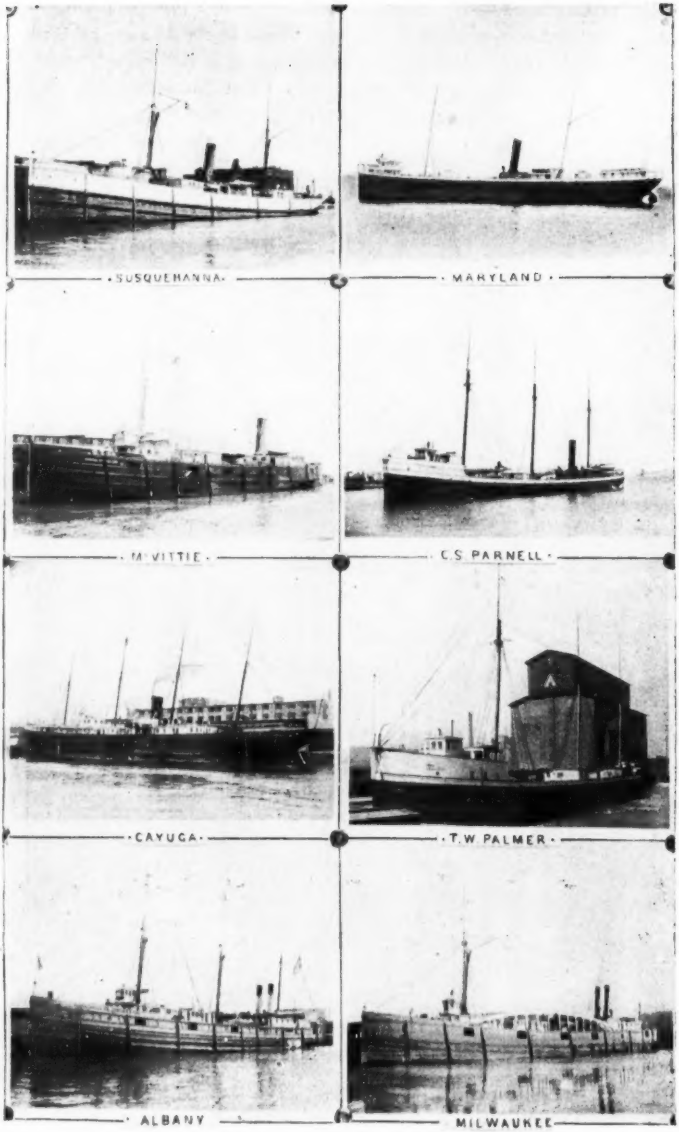
The tonnage passing Detroit in 1890 was 21,888,472 tons,—a million tons greater than that of the entire foreign and coastwise trade of London. The total freight carried in 1892, estimated on the basis of the Census of 1890, was over 34,000,000 tons, valued at nearly $400,000,000. It included over 9,000,000 tons of iron ore, 4,500,000 tons of flour and grain, 6,000,000 tons of coal, 7,000,000 tons of lumber, 3,000,000 tons of foreign merchandise, and 4,500,000 tons of other coarse products and domestic merchandise. The commerce of Cleveland alone exceeded 10,000,000 tons in 1892; equaling that of either of the great ports of Liverpool or Hamburg in weight, and twice that of either Glasgow or Hull. The tonnage passing through the St. Mary's Falls canal is greater in the lake season (seven-and-a-half months) than that passing through the Suez canal in the whole year.

The marvelous development of the lake marine is even more

strikingly emphasized by a retrospective view. The first steam-vessel launched on the upper lakes was *Walk-in-the-Water*, built at Black Rock in 1818. Her advent in Cleveland is still remembered. In 1849 the total tonnage was 161,832 tons, valued at $7,868,000. In 1862 there were 350 steamers, aggregating 125,620 tons, and 1152 sailing vessels, with a capacity of 257,689 tons, the total value being $11,862,450. In 1891 there were 1592 steamers and 2008



ENGINE FOR THE STEAMER "SELWYN EDDY."



A GROUP OF LAKE STEAMERS.

sailing vessels, aggregating 1,154,870 tons and valued at $70,000,000. More tonnage was put afloat in the past four years than was in existence on the lakes at the close of the civil war. In value the output of the past two years is double that of the whole lake fleet in 1865.

All of this growth applies only to the United States coast-line of 3000 miles. There has been no growth at all on the equally extended Canadian coast-line, owing chiefly to the policy of the United States government, which requires American vessels to be built in American ports and does not permit Canadian vessels to traffic between American ports. But the possibilities of development on that other coast-line when "manifest destiny" shall have been realized are of striking importance. A hint of the extent of the commerce north and south when the imaginary boundary between American and British possessions shall have been obliterated is given by the recent lease of the London and Port Stanley Railway, in Canada, to Cleveland capitalists, for twenty years. One passenger- and two freight-steamers will run on the route between Cleveland and Port Stanley. The leased line has direct connection with every trunk-line railway in Canada. Already 400,000 tons of coal have been contracted for, to be delivered in Canada the coming season.

The whole western peninsula of Canada can be supplied with coal from Ohio more cheaply than from any other section. The new water-and-rail international line has secured ample dock facilities on both sides of the lake, and expects to do a large passenger and freight business. It is only ninety miles from Cleveland to Port Stanley, and Toronto is considerably nearer to Cleveland than is Cincinnati. But the future outlook points to a ship-canal for vessels of the largest class across the Niagara peninsula and around the St. Lawrence rapids, and the opening up of the whole lake system to unobstructed foreign commerce, as significantly as it does to free intercourse across the present boundary line that divides the lakes.

The ship-building industry on the lakes, including engine-, boiler-, and other machine-works, comprises over thirty firms, with an invested capital of $15,000,000 to $18,000,000, aside from the builders of small craft not represented in the registered tonnage. A few of the large establishments still construct wooden vessels; the business of others is largely confined to repairs; and some of them have great dry-docks for repairs and are builders of

iron and steel, wooden, or composite vessels, or all of these, as well. Their united capacity is equal to that of all the sea-coast and river ship-yards combined.

One of the most extensive ship-building establishments in the United States is that of the Globe Iron Works Company of Cleveland. Although in operation only six years, this company has constructed thirty-eight fine steamers, of which thirty-three exceed 2500 tons carrying capacity each, and equipped them with engines and boilers from its own works. The *Mariposa*, launched in June, 1892, by this company, is one of the largest steamships on the lakes, having a length over all of 350 feet, 45 feet beam, and 24½ feet molded depth. She has triple-expansion engines, and can carry 3800 net tons on a draught of 15½ feet. During the past season the company constructed two light-house tenders for the United States, the *Lilac* and the *Columbine*, the former for service at Portland, Maine, and the latter at Portland, Oregon. There are now in process of construction in the company's yards two of the largest passenger steamships in the country. They are for the Northern Steamship Company, and will run between Buffalo and Duluth, stopping only at Cleveland and Detroit. They will each be 380 feet in length over all, 44 feet beam, and 34 feet deep, with accommodations for over 600 passengers. The engines of each will develop 7000 horse power, and the estimated speed is twenty miles an hour. Their cost will be $500,000 each. These lake greyhounds will draw 18 feet of water in the open lakes, to secure greater steadiness and comfort to passengers; but in the rivers only 15½ feet, the change in draught being effected by means of water ballast.

The value of a lake steamship to her owners was well exhibited in a paper read at the Fifth International Congress of Inland Marine, held in Paris in 1892, by a Cleveland delegate. The record used for illustration was that of the steamship *Manola*, built by the Globe company for the Minnesota Steamship Company. This vessel is 308 feet over all in length and has a carrying capacity of 2800 tons on 15½ feet of water. From the detailed statement read the following figures are compiled:

Freight earnings	$93,738.25
Earnings per ton of freight	1.32
Expenses of the season	$55,114.20
Expenses per ton of freight	.77
Net earnings	$38,624.05
Total miles traveled	50,584

Average miles per day	227½
Tons freight carried	71,170
Average tons fuel per trip	184½
Number of trips	30
Average size cargo, tons	2,296
Average draught of water, feet	14¾
Average time loading, hours	7¼
Average time unloading, hours	12
Time in commission, days	220
Actual sailing time, days	175
Actual time in port, days	45
Average mileage per trip	1,686

The cost of the *Manola* was probably about $185,000, showing a handsome profit on the investment.

The limited depth of water in the Detroit, St. Clair, and St. Mary's rivers, and the demand for the maximum carrying capacity in vessels of that draught, has led to the construction of new and interesting types of steamers. One of these novel types, devised by the Cleveland Shipbuilding Company, is known as the "monitor." Afloat, it looks very much like a "whaleback," except that it has limited upper-works forward; but below the load-line the construction is the same as in the ordinary types of coarse freight carriers. There are no upper-works for the greater part of the length of the vessel, the sides "tumbling home" rapidly above the load-line, and the upper deck being only wide enough for the hatches. The weight of material thus saved is added to the carrying capacity. The Company has on the stocks a vessel of this type that will be 324 feet long over all, and 42 feet beam, and will have a carrying capacity of about 3000 tons. Another vessel of the same size, but of the ordinary type, is on the stocks in the same yard. This company has turned out a number of fine steamships, but the most famous, perhaps, is the steel steam yacht *Wadena*, owned by Mr. J. H. Wade, which has circumnavigated the globe, visiting all the principal seaports. She is 160 feet over all in length and has a registry of 200 tons.

The pioneer in iron-and-steel shipbuilding on the lakes is the establishment of the Detroit Dry Dock Company at Detroit and Wyandotte. The Wyandotte yards were started in 1870 by Messrs F. E. and F. A. Kirby, Captain E. B. Ward having a large interest therein. The first vessel launched was the steamer *E. B. Ward* which, after a few seasons on the lakes, was transferred to a route between New Orleans and Cuba. In 1879 the Wyandotte

establishment was absorbed by the Detroit Dry Dock Company, which has large dry-docks at Detroit, and which for many years had been building wooden vessels, the Messrs. Kirby remaining in charge as engineer and manager, respectively, at Wyandotte. Since 1870 the Wyandotte yard has turned out 115 vessels, most of them of the largest class, and has four others on the stocks. The season's work for 1892 included seven steel steamers, whose aggregate cost was $1,748,000. Among these are a car-transfer steamer costing $325,000 for the Straits of Mackinaw; two new passenger steamers, the *New City of Alpena* and *New City of Mackinaw*, for the Detroit and Cleveland Steam Navigation Company, costing $275,000 each; the *Selwyn Eddy*, a fine passenger steamer now receiving the finishing touches; and three steel freighters. This establishment has constructed iron and steel vessels since it was started to the value of nearly $18,000,000, and including massive ice-crushing steamers for transferring railway cars across the Detroit river and Straits of Mackinaw, big tugs for ocean service, side-wheel and screw passenger-steamers, freighters of the largest and fastest types, and pleasure yachts.

The most recent and most novel type of vessel constructed on the lakes is the "whaleback," invented by Captain Alexander McDougall. The American Steel Barge Company of New York was organized three or four years ago for the construction of these vessels, with Colgate Hoyt as president, and Captain McDougall as general manager, and with ample capital. The works of the company are at West Superior, Wisconsin, and in their brief history they have eclipsed all records for speedy construction. The whaleback passsenger steamer *Christopher Columbus*, designed for carrying passengers from Chicago to Jackson Park during the World's Fair, was launched in fifty-six days from the date of laying her keel. She is 362 feet over all, 42 feet beam, and 24 feet deep, with accommodations for 5000 passengers. It is intended that she shall be the most handsomely appointed and embellished excursion steamer in the world. The iron ore for the steamer was mined in the Gogebic hills not 100 miles from the yard, the pig-iron was run out in the Duluth furnaces, and the steel was rolled in the Superior plant.

The whaleback freighters were devised to give the utmost carrying capacity on a given draught, all the upper works forward of the engines having been sacrificed. The construction is also more economical, a vessel of this type costing about $100,000

having carried 3025 gross tons of iron ore at one trip. The whalebacks have developed peculiar sea-going advantages, heavy seas sweeping over them without the shock received by vessels built high above the water-line. The company expects to launch one of these vessels every three weeks this year. One of the steamers built by them, the *Joseph L. Colby*, is in use on the Atlantic coast. Another, the *Charles L. Wetmore*, went to the Pacific coast.

By the way, the lake ship-builders have built several vessels for ocean service that were too large for the canal locks. Such vessels are cut in half at Buffalo, the severed ends closed up so as to go through the locks in two parts, and at tide-water on the St. Lawrence they are put together again.

One of the finest and largest steamships launched the past year was the *Maritana*, at the yards of the Chicago Shipbuilding Company, at Colehour, on the Calumet river. She is 348 feet over all, 45 feet beam, and 24½ feet deep. Her tonnage is 2957 gross tons.

An essential adjunct of the ship-building industry and the lake marine are the dry docks, some of the largest of which are owned by corporations that do not build ships. The Ship Owner's Dry Dock Company of Cleveland has docks capable of receiving the largest vessel on the lakes; and the Cleveland Dry Dock Company is constructing a new dock 360 feet in length, 88 feet wide on the top, 50 feet on the bottom, and with 18 feet of water on the gate-sill. There are also dry-docks of large size at Buffalo, Detroit, Milwaukee, and Chicago, and smaller ones at other points.

Other important firms and corporations engaged in ship-building on the lakes are F. W. Wheeler & Co. and James Davidson, West Bay City; Union Dry Dock Co., David Bell, and William Murphy, Buffalo; Craig Shipbuilding Co., Toledo; Milwaukee Shipyard Co., Milwaukee, and Alexander Anderson, Marine City. F. W. Wheeler & Co. have three steel freight steamers of the largest size under contract and two large wooden vessels. This firm was the successful bidder for one of the United States war-ships a year or two ago, but failed to secure the contract because the treaty with Great Britain does not permit the building of such vessels on the lakes. They have built two steamships for ocean service, of which the *Mackinaw* is of 4000 tons burden. On the other side of the boundary line, in Canada, the Hamilton Bridge Company, at Hamilton, the Montreal Transportation Company, at Kingston, and the Polson Iron Works, at Owen Sound, all have large steel or iron steamers under construction.

IS THE CLIMATE CHANGING?

By H. A. Hazen.

THE month of January, 1893, was marked in portions of the United States by the longest protracted cold season that has been recorded since accurate observations were begun by the Signal Service, twenty-three years ago. This fact has given rise, in many minds, to the question whether the climate is changing. From the 4th to the 20th of the month named the temperature in Washington city was 18° below the normal, and the maximum, which on the average goes *below* freezing but three times, went *above* it but once, and then to only 34°, during the same time. At Bismarck, North Dakota, the temperature was 5° *above* the normal. Thus the Washington temperature relative to that at Bismarck was 23° lower than usual. Many hold to the theory that our cold comes from the extreme Northwest, but this could hardly have been true in the case quoted. A singular fact is that usually storms going to the northward draw in the warm south wind and heat up the air, but that condition has apparently had the opposite effect this year, and this is due to the southward trend of the high areas, which has given an abnormal cold season to the South and cold South winds to the North.

It is probable that our upper atmosphere has been greatly cooled to enormous heights. January and February, 1875, were the coldest months experienced on Mount Washington (6300 feet high), and they were also the coldest months at Burlington, Vermont, near the base of the mountain. There has been no extensive and intense cold wave this season as we have had in one or two years before, but there has been a steady cold. The high areas and storms have had a very great velocity, and it seems reasonable to conclude that this has tended to prevent a heating from convection currents set up at the earth's surface, and also the rapid motion has set up vortices which have caused a stirring up of the warmer lower air with the colder above. It is the general opinion that of late our winters have greatly moderated, though some believe to the contrary. The records do not show any very great change, the average temperature in ten-year periods having remained constant. We are more likely to remember the great blizzard of March, 1888, than the great warmth of 1880.

Some have thought that the rainfall of our western country has gradually increased since its settlement was begun. Fine crops now grow where it is thought that none could have been produced fifty years ago. In this case, however, it seems more than probable that the rainfall has been kept in the ground by the tilling of the soil, instead of running off at once to the rivers; also, that the growth of plants has kept the air more humid, which has been favorable to vegetation. It has been suggested that the extension of railroads has permitted a distribution of electricity, and has attracted thunder and other violent storms to the western country. One person who held this theory visited a town two years after a tornado and, seeing the railroad, promulgated this view. Unfortunately, however, it was shown subsequently that the railroad was there at the time of the tornado. The opinion has been expressed that the building up of blocks and the great quantity of heat from chimneys in large cities must moderate the cold. It is evident that the winds would be much broken up in a large city, but it is not probable that a well-exposed thermometer would show any appreciable difference between the city and country.

If we would study this question of possible secular change in climate, we must broaden our view and seek for evidence in the past rather than the present. I shall not refer to so-called geological climates, which require tens or hundreds of thousands of years for their completion or modification, but shall confine the discussion to historic times.

First, we may consider whether the earth is gradually drying up, as has been asserted by Professor J. D. Whitney, of Harvard University, in his interesting and exhaustive memoir on climatic changes. If this proposition be true, it behooves the engineers of the world to begin at once a most careful system for preserving the waters that fall upon the land and for preventing their rapid descent to the ocean. Some of the points in support of this hypothesis may be briefly enumerated:

I. Large bodies of water, like Lake Bonneville in the western United States and others in Asia, have either dried up entirely or become marshes.

II. Arabia once supported a teeming population, but thousands have died from famine even within historic times, and this land is becoming a wilderness.

III. Persia is, if anything, much worse off than Arabia. The magnificent and wealthy cities within her borders, indicating the

existence at one time of a vast multitude of people, have all entirely disappeared or gone to decay.

IV. The land of Palestine, once "a land flowing with milk and honey," is now a howling waste.

These proofs, however, are inadequate. The traces of the large bodies of water which have been mentioned do not necessarily indicate an enormously increased rainfall during their existence. They were probably products of the glacial epoch, and may have been due to the advance of large bodies of ice from the north. It is certain that they date back tens of thousands of years. Their disappearance simply indicates the gradual establishment of an equilibrium between rainfall or the flow of rivers and evaporation.

There are three divisions of land surface of Arabia: (1) a strip bordering on the seas of some fertility and well watered; (2) a strip just in the interior, and not very wide, which is a desert proper; and (3) a wide-extended plateau region of the interior, supporting a large population and quite fertile. The lands of Arabia near the seas are frequently spoken of as having been a desert more than 3000 years ago, and the proof is quite strong that no change has occurred within that time. The case of Persia is slightly different. The soil is said to be a dark mold and of astonishing fertility at this day when properly watered. The annual rainfall is placed at about 11 inches, though this is much increased toward the north. The ancient fruitfulness of this land was undoubtedly due to the irrigation works, of which traces are yet seen. The continual marauding expeditions and civil dissensions recorded by historians account for the changes in this region. But the best proof of the fixity of climate in historic times is to be found in Palestine. Mention is made of the "first and latter rain," and the extreme dependence of the crops upon them, 3500 years ago. At the present time the rains begin in October, thus making it possible to sow grain, and the last rain of the year falls in April and the early part of May. The annual rainfall at Jerusalem averages 22.76 inches, nearly half of which falls in January and February or during the growing season. The rainfall is abundant, distributed as it is, for the best of crops; indeed, the climate has been likened to that of California. The quantity of rain has diminished slightly if at all in these thirty-five centuries, for we read of the Jordan overflowing all its banks in April, precisely as it does to-day. The cause of the present decadence of Palestine is to be found in the continual depredations which have been going on for so many centuries.

No mention is made here of the effect of denuding these regions of their forests in diminishing the rainfall. This subject is altogether too vast and too complicated to be here treated. It may be noted in passing, however, that where a large region is entirely bereft of a forest growth, leaving a more or less sandy plain, the air above the sand would become abnormally heated and dried, and as a result though all the causes acting in producing rain might be active and even the rain might fall at some height above the earth, yet it would be evaporated before it could reach the earth. On the other hand, if shoots are allowed to spring up from the stumps and form a dense growth, or if the land is cultivated and crops are grown, it is easy to see that the air above such a region would remain essentially as before the forest was removed and no diminished rainfall would be noted.

Our author gives as a cause of this general drying up of these vast regions, a gradual increase in the land surface of the globe. Such decrease at the expense of the water surface would tend to less evaporation, and as a consequence of this the rainfall would be diminished. It should be noted:

I. As the earth shrinks from cooling, unless the water finds its way by crevices into the interior of the outer crust, we would naturally expect the land surface to diminish and not to increase.

II. If any such general cause were acting, the lack of rain would hardly be noted in such restricted localities, but rather over the whole earth.

III. Even granting that the oceans are growing deeper and land surfaces higher,—a fact most strenuously opposed by some who even maintain that the land is all going into the ocean, because of the scouring action of rainfall and streams,—we must still conclude that the amount of such change has been inappreciable in historic times.

As a final argument, to prove that the earth is drying up, our author advances the opinion that it is gradually becoming colder. As a consequence of this refrigeration there is less evaporation and of course less precipitation. It was decided many years ago that the gradual cooling of the earth has ceased to have any influence upon the temperature of its surface. The attempt to use this argument in connection with a possible dessication of the earth utterly fails for the reason that we have the most abundant evidence that, over the temperate regions of the earth, a *fall* in temperature causes an *increase* of precipitation. This is proved by hundreds of maps

and tables published in the United States and in Europe. The reason for this is not far to seek. How often we hear the expression, "What a hot, dry spell!" During droughts the temperature is invariably above the normal. At such times the earth and air above it become abnormally heated and dried, and even if all the causes producing rain were present, yet none of it could reach the earth.

Proofs of this cooling are thus stated: The people of Scandinavia, despairing at last of making a living in their gradually cooling country, have found a home in our own country and in Canada. The same may be said of Iceland. Greenland, named so a dozen centuries ago from the character of the landscape, has become almost deserted and now seems capable of sustaining a very meager population. The name given to the month of November in Russia signifies "falling leaf." If the people of these northern countries have come to their settlements in Canada and the United States to escape from the cold, they have made a most serious blunder, for the climate was much milder in their former homes. Iceland was named from the abundance of its ice, and we may well suppose that these Northmen, skirting along the coast and arriving at the southern extremity of Greenland at a time of year when vegetation was abundant, would name the country Greenland. It may well be that the original colonies established in Greenland and frequently added to from the home country would rapidly deteriorate when such additions became infrequent, as they are known to have become. The question of the apparent lateness of the season many centuries ago, as shown in the naming of November, is one for philologists to discuss and is certainly very interesting, but cannot have any weight in the face of facts which abundantly establish the view that there has been no appreciable change in temperature for at least 3000 years. Some of these proofs may be briefly alluded to.

In Palestine the existence of the date-palm and the vine is distinctly mentioned more than thirty-three centuries ago. Both these exist there to-day. The early harvest is mentioned as occurring in April, just as it does to-day after the lapse of 3300 years. In Egypt dried plants have been found in mummy-cases 4000 years old, which show the same flora in that distant past as at present. We may well suppose that a permanent change of 10° F. in either of these countries would effect a most marked change in the dates of harvest and character of the plants. Biot has shown by historical references, going back thousands of years in China,

that there has been no change in that country in the character of their cultivated plants, in the dates of breeding silk-worms, or of the migration of birds. In more modern times we have rather reliable records of natural phenomena that take us back several hundred years. For example a record of the breaking up of the ice in the river Düna at Riga, Russia, has been kept since 1530.

The following table shows the dates in 7 periods of fifty-four years each, except the last, which contains but thirty-two years:

Period.	Number of Records.	Mean Date.
I (1530-1584)	25	March 27
II	27	March 28
III	12	March 19
IV	38	March 26
V	54	March 25
VI	53	March 27
VII	32	March 27

It is commonly believed, in parts of France, that the vineyards are gradually being crowded farther and farther south because of an increasing cold. Fortunately there exists a fairly good record of the dates of the vintages in Dijon, going back to the fourteenth century. The following table exhibits the mean date for each fifty years from 1380 to 1880:

Period.	Years Included.	Mean Date.
I	1380-1429	September 22
II	1430-1479	September 26
III	1480-1529	September 27
IV	1530-1579	September 28
V	1580-1629	September 28
VI	1630-1679	September 23
VII	1680-1729	September 24
VIII	1730-1779	October 1
IX	1780-1829	October 2
X	1830-1880	September 27

We see a most remarkable uniformity in these dates, which show no appreciable change in 500 years. Neither of these illustrations is advanced as of very great critical value. May it not be that the character of the vine in France has changed somewhat in the passing centuries? Possibly it is not so hardy as formerly, or the ground may have ceased to give good fruit after being replanted so long, or harmful parasites, bacteria, or diseases may make the industry unprofitable in some parts. We see that it is not at all necessary to resort to a change of climate to account for such

phenomena. The Northmen named New England "Vineland" 900 years ago, but it might well be that in the fall of the year they found wild grapes growing, and ripe, even as we find them in New England to day, so that there is no indication of a change of climate in this fact.

A very interesting series of historical references, since the year 1 A. D., to severe cold in different years has been collected by various investigators. In a short search I have found 323. Of these 71 were before the year 1000 A. D., 113 from 1001 to 1500, and 139 from 1501 to 1850. Making due allowance for the spirit of exaggeration in such accounts, and for the widely-separated regions reporting these phenomena, there still seems to be a distinctly marked tendency to severer cold in the years before 1500 than since that time. However, the allusions are altogether too indefinite to pin one's faith to them.

If we had accurate records of rainfall and temperature going back 200 years, they would materially assist in this discussion. Rainfall observations were made in Paris as far back as the end of the 17th century, and in England and Padua, Italy, since 1725. The two first indicate a rather remarkable diminution in rainfall during the first half of the 18th century, but no secular change seems to have occurred since 1750. The Padua record does not agree with either of these. The following figures show a combination of the records in periods of 25 years. The first Paris record is for only 6 years, and is not to be given much weight. Prof. Symons has investigated the rainfall of Great Britain, and he was the first to adopt the method of dividing the precipitation of each year by the mean for all the years. That is, 100 would indicate normal precipitation and less than 100 below normal, and so on.

RAINFALL RECORDS BY PERIODS OF 25 YEARS.

Period.	Paris.	England.	Padua.	Milan.
1690–1695	103.5	....	....	....
1700–1724	90.4	....	....	....
1725–1750	83.7	81.7	98.2	....
1751–1775	....	94.4	114.0	....
1776–1800	95.5	93.4	100.9	93.6
1801–1825	98.3	96.4	94.9	101.3
1826–1850	103.8	101.3	93.7	109.2
1851–1875	104 0	96.8	97.1	99.2

This table shows the unsatisfactory character of these observations. It can hardly be that two stations so near together as the

two last should have such a wide difference. Omitting Padua, the others show a very fair agreement.

Records of temperature have been compiled for St. Petersburg, as far back as 1720, but the table is much broken. The earliest complete record is at Padua, which begins in 1725, but unfortunately only a very approximate reduction can be made of this early record to the modern thermometric scale. We have little or no information as to the exact hours of observation, the character of the exposure of the thermometer, and the constancy of the instrument, so that a critical discussion of these early observations is impossible. They do not show, however, that there has been any appreciable change in air temperature in 170 years. From a study of a temperature record at New Haven, Connecticut, going back to 1787, Prof. Loomis found a tendency to warmer winters and cooler summers in the later years, and this corresponds with an almost universal belief among "oldest inhabitants."

A comparison of the distribution of pressure, temperature, and winds during the coldest and warmest winter might be of some assistance. Almost the coldest January experienced at Chicago in sixty years was in 1888, which had a mean temperature of 15°.1 or 9° *below* the normal, while in February, 1882, the temperature was 38°.2, or 12° *above* the normal. An examination of the mean charts for these months in the *Monthly Weather Review* shows a striking difference. In January, 1888, there was an area of high pressure 30″.35 central over South Dakota, there was no high area over the south-eastern States, but a low area was central over Newfoundland. This distribution of pressure gave rise to intense cold waves and high northwest winds, which combined to lower the temperature. The isotherm of 20° passed very near the parallel of 40°. On the other hand, in February, 1882, there was a marked high area (30″.25) to the west of the Rocky Mountains and a second high area over the southeast Atlantic States with a low area over Lake Superior. This caused southerly winds and the abnormal heat. The isotherm of 40° passes on this map very near that of 20° on the other. Here we see a vastly greater difference between the two months only six years apart than we can possibly consider as having permanently occurred in the last 400 years. In the one case the high areas with attending cold waves came down from the north far to the east of the Rockies; in the other the Rockies formed a sort of barrier to the onward progress of the cold waves. If the paths of these highs and lows were ever to shift permanently

either one way or the other, we might have a permanent change in climate as indicated by the character of these two months. We may be reasonably certain, however, that no change of this kind will occur.

It is a most remarkable fact that, though much of Europe lies 800 miles farther north than our own country, yet the winter climate is vastly milder there than here. A cold wave such as occurs a dozen times a year in this country is never felt there. At one time it was the custom to ascribe this amelioration of the winters in Europe to the Gulf stream, which washes the northern shores, but the effect of this must be entirely insignificant. In Siberia the winter pressure often reaches 31″.00 and the very clear sky induces intense radiation and a phenomenal degree of cold, frequently 60° below zero, F., which has been experienced only a very few times in Montana and Dakota. This cold, however, does not travel. A part of the warmth over Europe is due to the southerly winds which blow toward the more or less permanent low pressure area over Iceland. The most important factors, however, are probably the lack of storms and high areas, the direction and velocity of the upper currents, and the vertical distribution of temperature. Sonnblick, a mountain station 4000 feet higher and 600 miles farther north than Mount Washington, has the same winter temperature as the latter. If Sonnblick were on this side the Atlantic, its winter temperature would probably be 40° lower than it now is. The winds on Sonnblick have a marked feature in blowing about half the time from a southerly direction and the other half from a northerly, while on Mount Washington the wind is nearly the whole time from the west. In Europe high areas remain stationary for two and three weeks, the stagnant air becomes abnormally heated, and this gives a higher temperature. The velocity of the upper current is very much reduced on Sonnblick as compared with Mount Washington. The gentle currents now blowing from the south and warm are brought back by the north wind and serve to keep up the warmth. It should be understood that these stagnant airs and mild winters do not indicate a more healthful climate by any means. It is easy to see that if any changes should occur the climate would be affected correspondingly. On the whole, after weighing all the evidence, we must conclude that there has been no appreciable change in our climate in historic times.

THE INCREASE OF SPEED ON RAILWAYS.

By William Barnet Le Van, M. Am. Soc. M. E.

A RECENT writer on fast passenger trains says: "The prevailing tendency towards fast railroad-trains is not a mere passing device for the improvement of business in a dull time, or to effect a special object; it is a legitimate response to definite and urgent popular demand. People insist upon traveling more rapidly. The railroads have fossilized the habits of leisure and deliberation that used to characterize our methods of going and coming. We are no longer satisfied unless we know that the rate of locomotion is being steadily increased. The progress which has been made in this respect is almost as remarkable as the original inauguration of the railroad as a competitor of the steamboat and stage-coach. Twenty years ago, for instance, it took forty hours to go to Chicago from New York, and fifteen hours to Pittsburgh from Philadelphia; now the former trip can be made in twenty-four, and the latter in ten hours. Still greater reductions of time have been made on certain lines for shorter distances; and each successive increase of speed is taken as an assurance of others to come in the regular order of things."

It may be said that in thus constantly demanding more rapid facilities of travel the people invite a corresponding increase of the rate of danger to be encountered; but it is very doubtful if this proposition can be maintained. The facts go to prove, rather, that faster trains develop greater care on the part of the railroad people, and that there is really little, if any, more liability to accidents on such account. As a rule, the "Wild Irishman" and "Flying Dutchman" and "Cannon Ball" trains are run on schedules so arranged as to insure the utmost degree of safety, so far as all ordinary contingencies are concerned. Their success depends largely upon this point, and the railroad companies well understand that they cannot afford to take any avoidable risk. The demand for increased speed carries with it the demand for increased prudence. Fast trains must have men of superior skill and caution to operate them; they must have good permanent-way to move upon; and they must be provided with all known appliances for security and comfort. The general effect, in short,

is to improve the railroad system in all respects, and to eliminate from it the carelessness and incompetency that would be a source of fixed peril under the slowest of time schedules. There must always be more or less danger on a railroad train, but it is by no means sure that anything is gained in the way of safety by taking a train which runs twenty miles an hour instead of one which goes five times as rapidly.

On all English railways a high rate of speed is maintained, and this, when kept at a regular rate, unchanged by numerous stops, is found to be safer than the lower rate, stopping often and subjecting machinery to concussions and jerks in starting and stopping, which disorder parts of the train more than is done by the uniform velocity of high speed. The writer has covered the space of five miles at the rate of seventy miles an hour, and, notwithstanding this extraordinary speed, there was an entire absence of oscillation. So far as any motion of the cars was concerned, it was impossible for the passengers to tell whether they were going at a rate of seventy miles an hour or twenty. The multiplication of fast trains, therefore, is a thing to be commended and encouraged; and the railroad authorities are wise to make them as fast as they can within reasonable limits of forethought and precaution.

The railway race in August, 1888, between London and Edinburgh has become a matter of history. This race demonstrated what can be accomplished on existing road-beds in fast speed for long continuous runs. The "Single" locomotives employed averaged as high as 57½ miles an hour, in the long-distance runs, thus showing how to save time.

The power of a locomotive depends principally upon two factors: its heating surface, and its traction,—that is to say, the weight resting upon the driving-wheels. The amount of adhesion required to turn to account the whole power which a locomotive is capable of developing varies, inversely, as the speed at which the locomotive is run,—*the higher the speed the less being the adhesion required.* Experiments have shown that the faster a locomotive runs, the greater is the production of steam per square foot of heating-surface, and consequently the greater is the amount of work developed. The greatest losses in power in locomotives are due to friction, and among the most important causes of friction are the coupling or parallel rods,—"by which the cranks on adjoining driving-wheels are coupled together,"—owing to the strains to which they are subjected by centrifugal force. This danger

increases with the distance apart of the wheels and the length of the rods, and the centrifugal force which acts on the rods increases with the number of revolutions of the wheels. Therefore large diameter of driving-wheels is desirable, from the fact that they will have to make fewer revolutions at a given train-speed. The centrifugal force exerted on the rods is then in inverse ratio to the diameter of the wheels; in other words, the larger the driving-wheels are, the less is the force.

The problem of very high speed must, therefore, be solved by *lessening* the *friction* and *increasing* the *power*, so as to overcome the resistance due to curves and grades that exist even on our most important roads. Large as their resistances may be, here and there, they are nothing in comparison with the "train resistances" properly so-called. The curves and grades are unquestion-

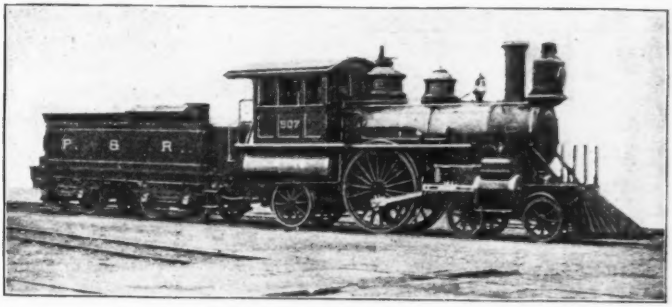


FIG. 1—FAST PASSENGER LOCOMOTIVE.

ably capable of considerable reduction, and in reducing them the necessary weight of our rolling-stock could be materially diminished, whereby less gravity would be incurred on grades and less centrifugal force developed on curves. The writer is satisfied that high speeds will be best accomplished with a locomotive having but one pair of driving-wheels, similar to locomotive "No. 5000" built by the Baldwin Locomotive Works, for the New York division of the Philadelphia and Reading railroad in 1880. Locomotives of this type are known in England as "singles," from the fact of their having but a single pair of driving-wheels. [See Figure 1.]

For great speed it has been demonstrated that "single" locomotives are not only cheaper in first cost and more efficient than "coupled" locomotives, but are also cheap in maintenance. The

majority of the fast runs on English railways are made with "single" locomotives, and their average loads are equal to the loads hauled in America, if not heavier than those of our fast trains. It has been shown by the experiments of M. Regray, locomotive-superintendent of the Eastern Railway of France, that the frictional losses in locomotives amount to about 35 per cent. of the total indicated horse-power of locomotives "coupled" by parallel rods.

Single locomotives run more freely and with less internal resistance than coupled locomotives. On one of the most important lines in England the saving in fuel effected by the use of single locomotives over coupled ones amounts to about 10 per cent. of the entire passenger-locomotive coal-bills. This being the fact, it is not wonderful that single locomotives in England have been substituted for coupled ones. Steel rails and the "steam-sanding"

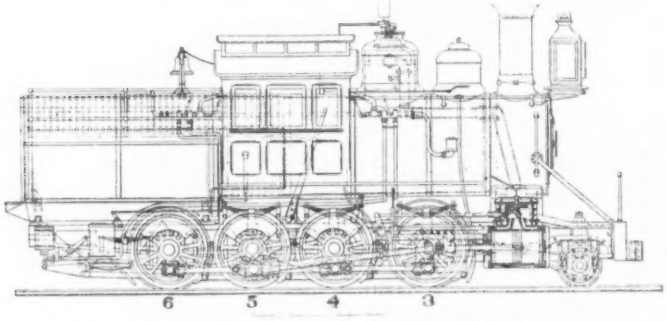


FIG. 2—FREIGHT LOCOMOTIVE—"CONSOLIDATION" TYPE.

apparatus have enabled these locomotives to carry as much as twenty tons on a single pair of drivers, where formerly fifteen tons was the maximum, and a calculation will show that in case of such a locomotive an average steam-pressure of at least sixty pounds per square inch throughout the whole stroke would be required to make the drivers slip if the adhesion was but one-fourth of the insistent weight.

Now to accomplish sixty miles in sixty consecutive minutes we will have to imitate the English by using single locomotives. This may be made more clear by the use of a few illustrations. We assume that we have a "Consolidation" locomotive (such as are used on the Pennsylvania railroad for hauling their heaviest trains) having a boiler resting on four pairs of driving-wheels and a "pony" truck [as shown in Figure 2], steam-cylinders 21 inches

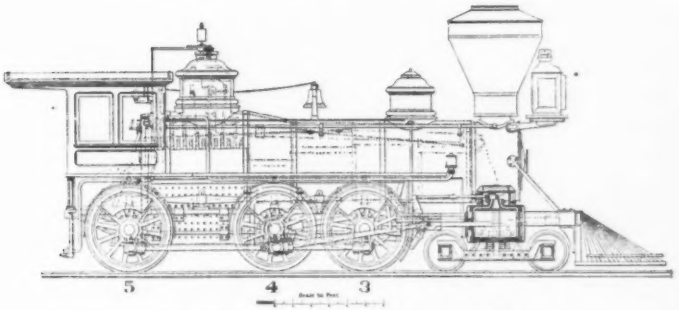


FIG. 3—FREIGHT LOCOMOTIVE—"TEN-WHEELED."

diameter and 24 inches stroke, capable of hauling 1500 tons, at say fifteen miles an hour. If we dispense with one pair of driving-wheels, say No. 6, and the pony truck, and replace the latter with a four-wheeled truck, making it a "ten-wheeler," we can haul 1000 tons at the rate of twenty miles an hour. [See Figure 3.]

Next, upon removing driving-wheels No. 5, making it an "American" passenger-locomotive, and also making a reduction in the diameter of the steam-cylinder of say three inches,—or eighteen inches in diameter,—we will be able to run at the rate of twenty-five miles an hour with a load of 800 tons, or at the rate of forty-five miles an hour hauling 250 tons. [See Figure 4.]

Finally, if we remove driving-wheels No. 4 and substitute a pair of trailing-wheels to support the back-end of the boiler, and increase driving-wheels No. 3 to eight feet in diameter, also increasing the stroke of the cylinder to twenty-eight inches in place of twenty-four and adding a steam sanding-apparatus, we can haul a load of 200 tons at the rate of *sixty miles* an hour. [See Figure 5.]

The increase in diameter of drivers reduces the number of revo-

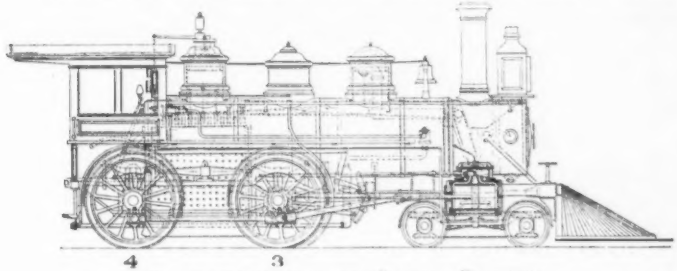


FIG. 4—PASSENGER LOCOMOTIVE—"AMERICAN" PATTERN.

lutions per mile, giving more time for the absorption of the heat in its passage through the flues of the boiler. The reduction of cylinder-diameters is compensated by the decreased load and friction of coupling- or side-rods, and also by the addition of the special steam-sanding arrangement. The adhesion or grip on rails is maintained by the single pair of driving-wheels, and this is just what the English superintendents have done. Why should we not do likewise?

Locomotives with one pair of drivers are not new in America. The "Ironsides," built by M. W. Baldwin in 1832, had but one pair of drivers. Mr. William Pettit ran her on the Philadelphia and Germantown railroad at the rate of sixty-two miles an hour. Dr. Patterson, of the University of Virginia, and Mr. Franklin Peale were on the locomotive and timed it running. In fact, all the fast locomotives built by the founder of the Baldwin Locomotive Works were single locomotives.

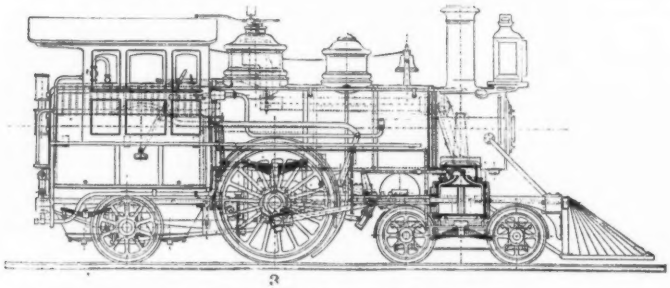


FIG. 5—"SINGLE" LOCOMOTIVE FOR FAST SPEEDS.

In 1849 Mr. Baldwin built for the Pennsylvania railroad three locomotives with a single driving-wheel six feet in diameter. President Taylor was taken in a special train over the road at a speed of sixty miles an hour. In 1880 the Baldwin Locomotive Works built a single locomotive for the Philadelphia and Reading fast express between Philadelphia and Jersey City, over the Bound Brook division, with a single pair of driving-wheels six-and-a-half feet diameter [see Figure 1.] The writer made a run on this locomotive on May 14, 1880, from Philadelphia to Jersey City, a distance of 89.4 miles, in 98 minutes, giving a mean speed of 54.73 miles per hour. There were four passenger-cars, the total weight of the train being 148 tons. On the return trip another car was added, increasing the weight to 168 tons, and the run back was performed in 100 minutes, a mean speed of 53.4 miles per hour.

In 1849 Edward S. Norris, of Schenectady, built for what was then the Utica and Schenectady railroad the "Lightning Crampton" with 16-inch cylinders, 22-inch stroke, and a single pair of driving-wheels seven feet in diameter, which ran at the rate of sixty miles an hour in 1850. In the same year Ross Winans, of Baltimore, built a single locomotive—the "Carroll of Carrollton"—with a driving-wheel of seven feet for the Boston and Worcester railroad. It was for an experiment in burning anthracite. The wheels were of wrought iron, and the first of the kind brought to America. The speed of this locomotive, under favorable circumstances, between Albany and Boston, with trains of seven to eight cars, was sixty miles an hour. The engineer, J. H. Jackman, says: "Since I ran

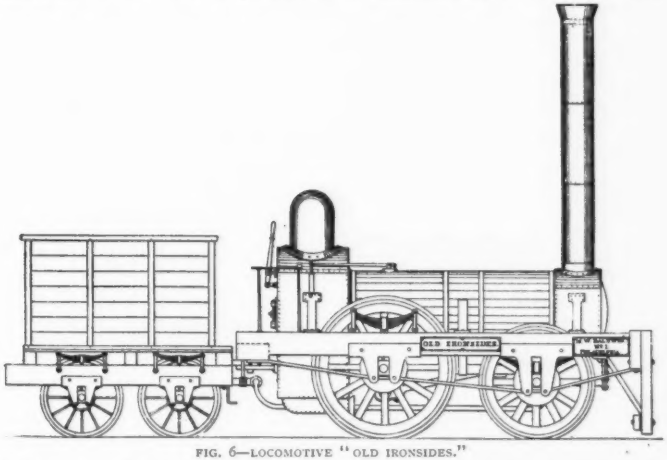


FIG. 6—LOCOMOTIVE "OLD IRONSIDES."

her in 1849, I have traveled many thousand miles on locomotives, and have seen some high speeds made; still I have never seen the locomotive that could lay right down to it and out-run the 'Carroll of Carrollton.'"

The earliest locomotives in England were "singles." To Mr. John Ramsbottom, formerly superintendent of the London and Northwestern railway, belongs the credit for making and producing the best results for long-distance fast passenger service, notably with the then favorite pattern on that road known as the "Lady of the Lake," built in 1862. The locomotive "Watt," one of the same class and build, ran the special train which conveyed the Queen's messenger bearing the despatches containing the decision

of the American Government to Stafford, a distance of 131 miles without a single stop. The run was made in 144 minutes, or at the rate of 54½ miles per hour. In the great London-Edinburgh race, in August, 1888, one of this class, the "Waverley" [see Figure 7], twenty years old, with drivers of seven-and-one-half feet, ran 158 miles in 169 minutes. This is the longest distance ever run without a stop, beating the 148-mile run between Chicago and Fort Wayne, on the Pennsylvania road, by ten miles. These remarkable runs were made without stopping, by the use of Ramsbottom's patent "pick-up" apparatus for supplying the tender with water while running, as shown by Figure 8. The troughs for this service are now in use on all the principal lines in the United States. By their use a train has been able to go from New York to Pittsburgh—438.5 miles—in one continuous run of 10 hours and 5 minutes, an average speed of 43½ miles an hour.

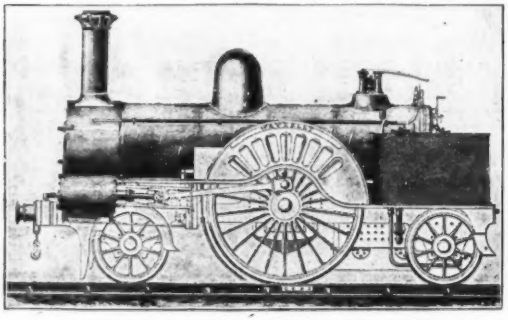


FIG. 7—LOCOMOTIVE "WAVERLEY"—"LADY OF THE LAKE" CLASS.

The most persistent advocate of single locomotives in England is Mr. Patrick Stirling, superintendent of the Great Northern railway, who in 1868 designed and built a single locomotive for working the fast passenger traffic from London to Manchester and Leeds. This locomotive had a 17″x24″ cylinder and a single pair of driving-wheels 7 feet in diameter. It gave such good results that in 1870 he commenced to build all his fast-passenger locomotives as "singles." Figure 9 shows the present type of loco-

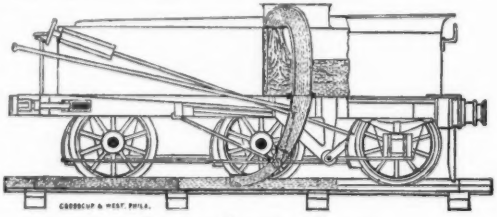


FIG. 8—TENDER "PICKING UP" WATER.

motives now in general use, with cylinder 18″x28″ and driving-wheels of eight feet. The Great Northern has a well-earned reputation for fast speed and punctuality of passenger service. Its Scotch expresses run from London to York, a distance of 188 miles, in 3 hours and 55 minutes, with a single stop of six minutes at Grantham; its Leeds expresses run 185½ miles in 3 hours and 55 minutes, with four stops, two of which aggregate 9 minutes, and its Sheffield expresses make the trip of 105 miles to Grantham in two hours. These trains are run day after day with a punctuality which is worthy of all praise. It was to deal with trains such as these, consisting of from eleven to twenty-six carriages, that Mr. Stirling introduced the single locomotives as shown in Figure 9. That this type has maintained its place for more than twenty years and is still being reproduced speaks most strongly for the single locomotive. In the great race of August, 1888, these locomotives averaged 55½ miles per hour for the month. The fast runs on the Caledonian railway of Scotland are made by "singles." The run during the race to Edinburgh in August, 1888, from Carlisle to Edinburgh, 100¾ miles, was made in 102 minutes and 33 seconds, or an average speed of 58.94 miles per hour.

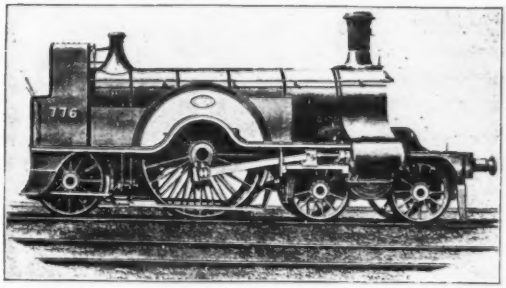


FIG. 9—"SINGLE" LOCOMOTIVE, GREAT NORTHERN RAILWAY.

Mr. S. W. Johnson, superintendent of the Midland railway, made some experiments as to the advantages of single versus coupled locomotives by removing the coupling-rods of one of his locomotives and running it as a single. The results were so satisfactory that he has adopted the former for the latter for his fast trains, as shown in Figure 12. The fast trains on the Midland average 240 tons, and the speed 50.7 miles an hour, and the consumption of coal per train-mile, including raising steam, is less than 26 pounds. The coupled locomotives in this country never consume less than 50 pounds per train-mile with the same weight of train. The Webb compound locomotive No. 1320 on the New York division of the Pennsylvania road is virtually a "single," as both pairs of drivers are

driven by separate cylinders. This locomotive hauls five cars, making seven stops, between Jersey City and Philadelphia in 109 minutes, with a coal consumption 25 per cent. less than is used by coupled locomotives doing similar work.

It is undeniable that for trains within their adhesive powers no class of locomotives can run with so much freedom and steadiness, and with so little wear and tear to the machine and permanent-way, at very high speeds, as single driving-wheeled locomotives. The Great Northern railway of England conducts its passenger traffic at a rate of speed higher than that of any line in the world, and with great regularity, with "single" locomotives having 8-feet driving wheels, greatly excelling the performance on other lines with coupled driving-wheels, and the economy of fuel of the former class over the latter is very remarkable. This no doubt is owing to their ample cylinder-power and large exhaust nozzles, which admit of the steam being used at a higher rate of expansion and a lower terminal pressure, and also a decrease in friction due to the removal of the parallel rods. These locomotives haul twenty-six coaches, averaging fifteen tons each, with a coal consumption of 26 pounds of coal per train-mile.

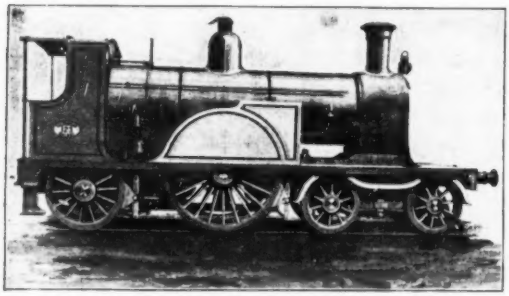


FIG. 10—CALEDONIAN RAILWAY, SCOTLAND.

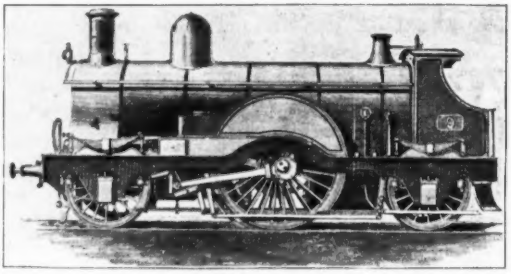


FIG. 11—GREAT WESTERN RAILWAY.

Objection to "singles" has been made in America on account

of the want of adhesion. In the latest improved single locomotives, however, the grip of the driving-wheels upon the rails is not secured entirely by excessive, insistent weight, as is usual in locomotives of this class, but a sand jet is placed directly in front of the driving-wheels, so arranged that the sand can be ejected either by compressed air from a Westinghouse reservoir or by steam directly under the tread of the driving-wheels. This jet of sand is always in operation when the traction requires it, while the locomotive is running with a train, and it is worked simultaneously with and by the same handle as the sand valves, the quantity of sand required when in constant operation being about one pound per mile. This system of sanding the rail has been found the most efficient in the preventing of slipping, and most economical in the use of sand. These improved steam-sanding apparatuses are now being largely adopted by all the English railways, as they completely remove many of the difficulties arising with the old method of letting the sand fall by gravity on the rail. When sand falls by gravity, owing to the small velocity with which the sand issues from the pipe, it is very liable in a side wind to be blown off so as to fall clear of the rail. It is, moreover, very wasteful of sand, as it is impossible to regulate the delivery so as to give a constant and even supply during any considerable time. All these objections, however, are obviated in the new apparatus, as the sand is delivered at a high velocity directly to the point of contact of the wheel and the rail, and the amount supplied can be controlled perfectly.

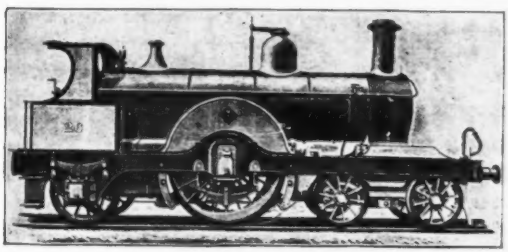


FIG. 12—SINGLE LOCOMOTIVE, MIDLAND RAILWAY, ENGLAND.

To maintain a high speed we must also reduce the dead-weight that now exists in our passenger cars. The ratio of carrying dead-weight to paying weight on our first-class roads averages 16 to 1. During the past fifteen years a great increase has been made in the weight of passenger-cars. This has been due partly to the greater space allowed each person carried, especially in parlor-cars. The increased capacity is due to the height being made much

greater than formerly. As far as comfort is concerned this is an advantage, but it increases the dead-weight and exposes additional area for the air to impinge upon. The running of three classes of cars involves a considerable proportion of dead-weight. There must be parlor-cars, even if there be no passengers to occupy them; and there is also a smoking-car beside the ordinary car, and as a general thing passengers occupy a seat in each of the latter for a portion of the journey. It is not often that each of the different classes of cars will have nearly its full complement of passengers.

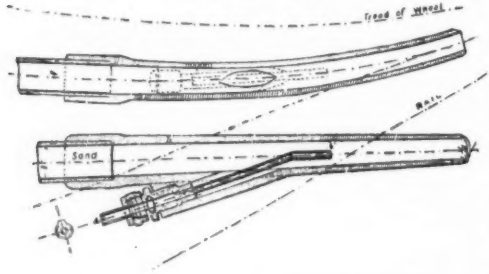


FIG. 13—COMPRESSED-AIR OR STEAM-SANDING-APPARATUS.

There can be but one opinion as to the relative dead-weight now carried and the vast importance of lessening it. It is time that attempts were made by railroad companies to introduce a new system of cars so as to reduce the amount of dead-weight as compared to paying-weight. To do this effectually each passenger must be assigned to one seat. I am satisfied that if trains were so made up, with light-weight cars, with comfortable armed seats, fitted with doors on the sides so that the cars could be coupled up close together,

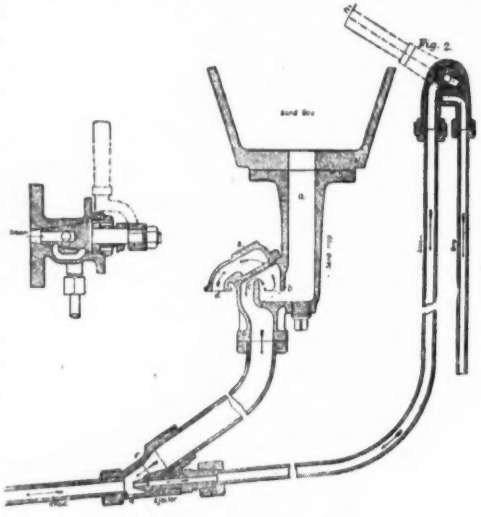


FIG. 14—STEAM-SANDING APPARATUS.

and parlor- and smoking-cars dispensed with, trains could be run between New York and Philadelphia inside of ninety minutes. As trains are now made up, a great many passengers expect not only a seat for their bodies but another for their feet or their wraps. If a seat were assigned to each passenger, and in case of man and wife a seat side by side, it would prevent the disgraceful sights witnessed daily at the entrances to the cars at our railroad stations where men, women, and children are pulling and crowding, each trying to reach the gate first so as to secure a seat.

No railroad will ever be economically run until stations are built upon summits with grades falling each way, so as to take advantage of gravity in starting, and of its resistance in stopping. Our locomotives are now built especially for starting the trains, although this involves not 5 per cent. of the work to be performed, making them wasteful for 95 per cent. of the power to be developed to haul the moving load.

In England the majority of the fast passenger trains are hauled by single locomotives at a speed of 53 miles an hour with a consumption of 26 pounds of coal per train mile, the weight of train being equal to our five-car trains, averaging 250 tons. The same weight of train in this country is hauled by a coupled locomotive at the rate of 43 miles an hour with a consumption of over 50 pounds of coal per train-mile. The English locomotives average 85,000 pounds in weight and the American locomotives 100,000 pounds. The driving-wheels of the former are 7 and 8 feet in diameter and large exhaust nozzles, the former reducing the number of revolutions per mile, thus producing a slow draft, allowing the products of combustion time for passing through the flues, so as to give up the greater portion of the heat evolved, thus effecting a higher evaporation per pound of coal burnt; and the latter reducing the back pressure on the pistons, the concurrence of which is the great drawback to high speeds; the trouble is not to get the steam into the cylinder, but to get it out quickly. The American locomotive has small-diameter driving-wheels and small exhaust nozzles, the former requiring more revolutions to the mile and less effect of the heat evolved in the flues, while the latter keeps the fuel dancing on the grates and burns the fuel to *carbonic oxid* in place of *carbonic acid*, meaning a loss of fully 4000 units heat per pound of fuel consumed. By the adoption of single locomotives the fast passenger-trains could be moved as fast as the English at a saving of 50 per cent. in fuel.

LOCATIONS FOR PIG-IRON PRODUCTION.

By John Birkinbine,

President American Institute of Mining Engineers.

THE advances which brought the United States to first position as a producer of iron ores, pig-iron, Bessemer steel, and other products, naturally drew attention to the importance of developing mineral resources lying dormant, and of establishing industries for the production and manufacture of iron and steel in new locations. To secure this, various methods for encouraging capital to embark in new enterprises have been employed, and the erection of blast-furnaces for the production of pig-iron has attracted first attention. If the statements of advantage, claimed for certain locations, as set forth in newspaper articles, or by special announcements in circulars, were all true, the United States would be unusually favored both by the number and the generous distribution of sites which are peculiarly adapted for the production of pig-iron, and sections of the country now sparsely populated should develop rapidly into series of adjoining commercial metropoli.

This country of great resources has before it great possibilities, and the liberal distribution of deposits of mineral undoubtedly offer numerous available sites for the establishment of iron-producing or iron-manufacturing plants, while an augmenting population will seek new industrial centers; but the available locations for successful iron manufactures or for future cities are by no means as numerous as the published statements referred to indicate. It is not necessary to assume that all or most of such statements were made without a basis, for in a large number of instances, and possibly in most of them, there have been apparent reasons leading to the assumption that peculiar advantages are possessed by special locations.

Iron ores, fuel, or flux, or all three, may occur within convenient distance of a site for a projected blast-furnace, and such site may have the added advantages of ample labor at satisfactory prices, good transportation facilities, etc.; yet the construction of a blast-furnace for the production of pig-iron may be followed by financial disaster. The quality of the ore, coal, and limestone, the quantities which can be advantageously assembled at the point for producing the metal, the method of winning these raw materials from the

ground, and the cost of mining and preparing them for the furnace, must enter into any estimate in which the advantages of erecting a new smelting-works are considered in comparison with those existing elsewhere.

A most important consideration is a convenient market for the product, for although improvement in railway construction and operation, and competition between different lines of traffic, have so reduced the transportation charges that localities hundreds of miles apart are now as close competitors as were those in former years which were separated by but a few miles, the advantage of consumption close at hand is by no means a small factor in determining the financial success or failure of an iron-producing enterprise.

Of the numerous schemes in which blast-furnaces have been used as foundations upon which to start real-estate speculation or town "booms," some have had little, if any, substantial basis, others have possessed one or more of the factors which are essential for the economic production of pig-metal, and some which have been started and progressed well on towards completion have already demonstrated the error of attempting to produce pig-iron or of using a blast-furnace as the initiative industrial feature for the establishment of manufacturing centers where other conditions do not demand such centers. The employés about a blast-furnace are not as a rule the best calculated to form nuclei of large populations. Outside of such as are paid salaries, few receive compensation above that given to ordinary labor, (except for the extra hours per day which they work), and the labor about blast-furnaces cannot be considered as fixed or permanent. Recognizing this, some of the promoters of town ventures secured the promise, or the actual establishment, of industries which would use a larger number of skilled employés, and generally such as obtained better wages than the blast-furnaces offer. Some of these advanced industries rely upon the product of blast-furnaces for their raw material, while others may be entirely independent of the furnaces. The industrial plants proposed or erected may either embody new equipments, or those moved from other sites and renewed in appointment so as to be creditable to any locality; but in other cases investments have been encouraged by the bodily removal to new sites of plants which have outlived their usefulness in their old locations, largely on account of antiquated equipment to which little or no addition was made for the changed conditions. Dis-

aster may be expected to follow enterprises established at locations which do not, as far as practicable, possess advantages equal or superior to others which have been in operation elsewhere for a term of years. A new industry, or the opening up of a new industrial district, must meet competition, and break into established trade held by older concerns,—a fact which often seems to be lost sight of by those who press the claims of some locations. Under ordinary conditions a new business venture is sufficiently handicapped in securing an entrance into active trade, and needs all the advantage which good equipment, substantial construction, economical management, and good financiering bring, to assist it in competing for a share of business.

If a blast furnace were necessarily the best starting-point for an industrial town or city, the number of such settlements in the older iron-producing districts would be greater than they are, but any one conversant with the location of existing blast-furnaces recognizes how many of these, although they have occupied the same location for a number of years and may have been well managed and operated with skill, have gathered scarcely more than a hamlet about them. On the other hand, a number of instances could be quoted where towns and cities have developed from a single forge or blast-furnace, which was erected in such location as to have the advantage of good and cheap raw materials and an ample market; in fact some new important settlements originated from the location of plants which did not possess all of the advantages named. But the exception proves the rule,—that the future advance in real estate, or the prospective establishment of towns or cities, should seldom have a prominent place in estimates when a location is to be chosen for the production of pig-iron. The prime considerations should rather be the quantity, quality, and cost at which raw materials and labor can be assembled, the character of pig iron which can be made, and the market offered for its sale.

An examination of the development of the pig-iron industry of the United States demonstrates the extent to which success has been and will continue to be affected by location, and a retrospect of the history of existing and apparently prosperous furnaces shows how many have met with financial difficulties, necessitating change of ownership or management, while to-day close attention and economy are essential for their continued activity.

If abundance of raw material only is required, there would be no necessity for the number of idle iron-ore mines which to-day are

scattered through some of the older iron-producing districts, convenient to fuel supplies; but the quality and the cost of winning the ore, as well as the quantity, must be considered. The material won from some of these idle mines was of very satisfactory character for the production of metal in demand until changed conditions of trade required ore of different composition; although some of the mines which are inactive produce ore of a quality equal or superior to that largely used in other sections of the country where the deposits are newer or can be worked more cheaply. Other mines have been wrought until the extraction of the ore renders insufficient profit to permit competition with richer ores brought from long distances.

If the abundance of satisfactory fuel obtained close to the plants were the chief necessity for economical operation of blast-furnaces, and if this could not be offset by other advantages, there would be no excuse for the existence of the magnificent iron- and steel-industry centered at Chicago; for there the blast-furnaces have no raw materials near at hand, except the limestone, and the per-diem rates of labor average higher than in some other sections of the country where pig-iron is made. On the other hand, if an abundant supply of iron ore offset the advantage of near fuel and a good market, the enormous output of the blast-furnaces in the vicinity of Pittsburgh would seem to be produced at a decided disadvantage, for with the exception of the local mill cinder and a partial dependence of some outlying furnaces upon local carbonates and brown hematites, all of the iron made in Pittsburgh and vicinity, in the Shenango valley of Pennsylvania, and the Mahoning valley of Ohio, as well as that produced about Wheeling, West Virginia, and Johnstown, Pennsylvania, is obtained by smelting iron ores brought from Lake Superior.

The surroundings which several decades ago made a location advantageous for the smelting of iron ores may have less weight in determining the erection of a blast-furnace plant at the present time, several causes combining to affect the influences which certain conditions exert. Owing to the increased production of blast-furnaces now constructed, due to the average size, the general use of richer ore mixtures, and the more intelligent management which is bestowed upon the operation of the existing plants, the number of blast-furnaces in the United States, either active or likely to be in operation, has declined since 1881, when 717 were recorded. In 1890—the year of our greatest pig-iron out-put—but

562 furnaces were on the active list; of these but 311 were in operation at the close of 1890, being a smaller number than in any of the preceding twelve years, with but three exceptions (1883, 1884, and 1885), in each of which the pig-iron output was less than half of what it was in 1890. The production of pig-iron in the years 1891 and 1892 did not reach that of 1890, but owing to some new plants having been completed or blown in, the number of furnaces was slightly increased. The record shows that in 1890 there were 562 furnaces on the active list, with an output of 9,202,703 gross tons; in 1891 the furnaces numbered 569, and the output was 8,279,870 gross tons; and in 1892 564 furnaces were reported, all of which, however, were not in operation, the tonnage for the year being 9,157,000 gross tons.

Therefore an increased output of pig-iron is secured from a decreased number of blast-furnaces, and as there is a growing tendency to centralize industries (groups of furnaces under one management becoming more common), there must necessarily be fewer specially available locations at the present time than formerly.

A quarter of a century ago a blast-furnace which averaged from thirty to thirty-five gross tons of pig-iron daily was recognized as of large size and doing excellent work. Now, a production exceeding two hundred tons per day by blast-furnaces is not considered remarkable, and where a number of large structures are combined under one management, they present a problem for assembling raw materials vastly different from that of the average furnace twenty-five years ago.

With the perfection of mining appliances, the intelligent management of mines, the facilities for winning or transporting ores, fuel, and flux, there may be really less personal supervision necessary in assembling the raw materials for one of the large plants than was demanded of the managers of the smaller ones who had to rehandle the material, and furnish at least a part of the transportation. But for the larger plants the basis of supply must necessarily be larger. Increased tonnage of ore, fuel, and flux demands greater available supplies, and hence dependence on merely local deposits of iron ore is now uncommon. Advances in the technology of blast-furnace operation, and the increasing demand for metal of special chemical compositions, also affect the reliance which may be placed upon local deposits of iron ores, for blast-furnace managers must work within narrow limits, as to the character of pig-iron made. Hence the location selected for plants

should be accessible to supplies of ores, from which such mixtures can be made as will permit of producing not only the grade, but the quality of metal required, at prices which admit of manufacturing it advantageously, so as to meet the available market.

The development of the Lake Superior region, which up to the close of 1892 contributed more than 74,000,000 gross tons of iron ore, is not alone due to the high percentage of iron representing the average of the ore produced, for the variety and composition of the ores which have been mined, and which fit them for different purposes, have had a marked influence in this development. In view of the generally-accepted belief in the prime necessity of ores of Bessemer grade, it may sound peculiar to assert that, had all of the iron ores won from the Lake Superior district been sufficiently low in phosphorus to be acceptable for the production of pig-iron for the Bessemer process, the development of this district would have been less rapid than it has been as a producer of the various grades of iron ore.

To emphasize this fact, it is unnecessary to go further back in history than a few years, for, if an interval of five years, ending December 31, 1891, be taken, and the proportionate amounts of Bessemer and other kinds of pig-iron produced are tabulated, such statement shows that in the year 1887 44.81 per cent. of the total pig-iron output of the country was of the Bessemer quality. In 1888 this percentage was reduced to 40.65 per cent., the total output of pig-iron being practically the same as in 1887. In 1889 there was an increase of more than 1,000,000 gross tons in the annual production of the country, and in that year the quantity of Bessemer pig-iron made was 41.45 per cent. of the total. Another increase of more than 1,500,000 tons brought the pig-iron made in the United States in 1890 to a total of 9,202,703 gross tons, of which 44.47 per cent. was of Bessemer quality. The year 1891 showed a decline from the production of 1890 of nearly 1,000,000 tons, and in that year 41.94 per cent. of the total was of Bessemer grade. The figures which have just been compiled for the year 1892 indicate that out of the total production of pig iron 9,157,000 gross tons, 48.53 per cent., was of Bessemer quality.

The growth of the Bessemer-steel manufacture in this country has been phenomenal, continuously increasing in twenty-five years from a product of 3000 tons to one of more than 14,000,000 gross tons, such an industry necessarily exerting a very marked influence upon the location of the furnaces which supply the metal

for it, and upon the development of iron ores which are used in these furnaces. It is probable that the majority of persons suppose the great steel works at Chicago, Pittsburgh, Baltimore, Harrisburg, Johnstown, Scranton, Bethlehem, Troy, etc., to have been located on account of blast-furnaces connected with them. It is undoubtedly true that some of these plants owe their existence to an original forge or blast-furnace, but an investigation will show that, properly speaking, the existing blast-furnaces were located at these points because of the steel-works, and are established so as to supply to large industrial plants the raw material upon which they must depend.

In a similar manner it may be shown that most of the blast-furnaces which are producing pig-iron of grades particularly adapted for the foundry or rolling-mill trade owe their situation more to convenience to a market for the product than to being specially near to supplies of fuel or of ore peculiarly suited for the product made. Taking the five years 1887, 1888, 1889, 1890, and 1891, the figures show that, while the blast-furnaces located in the vicinity of Pittsburgh and in western Pennsylvania and eastern Ohio increased their total output of pig-iron nearly 50 per cent., much of this growth was in the production of Bessemer pig-iron, the annual output of which augmented nearly 80 per cent. But on the other hand, while the State of Illinois increased its total production of pig-iron one third, its output of Bessemer metal was augmented but one-tenth in the five years named: that is, in spite of the State of Alabama trebling its output of foundry and mill pig-iron in five years, and other southern States adding to the volume of this class of metal, the State of Illinois, with its large steel industry, accessible to liberal supplies of iron ore suitable for producing Bessemer pig-iron, increased the quantity of ordinary pig-metal produced three times as rapidly as that used for Bessemer purposes. The advance figures of pig-iron production for the year 1892, just published, show a decided increase in the quantity of Bessemer pig-iron made, the tonnage and the proportion of this metal being greater than in any other year. At present writing the relative amounts for specific districts cannot be given exactly, but a comparison of the records of the years 1887 and 1892 indicate the following: In the Pittsburgh district the output of Bessemer pig-iron was more than double, while the total of all kinds of pig metal increased less than 80 per cent., showing a gain in Bessemer pig-iron at the expense of mill and foundry iron. Similarly the greater

portion of the advance in Illinois last year was in Bessemer pig-iron, the increase in six years being 88 per cent. in the production of total pig-iron, and 63 per cent. in that of Bessemer pig-iron. Alabama's product, none of which was Bessemer pig-iron, was two and one-half times greater in 1892 than in 1887.

The influence of location upon the pig-iron industry would seem, therefore, to be based not only upon the possibility of assembling the raw materials, but also upon the opportunities for marketing the product advantageously. A blast-furnace may act temporarily as a sign-board for a real-estate "boom," although its operation may be at a financial loss, but ultimately dividends or profit must come from it, or failure will be written against it. A smelting-plant may instil life into a district, and cause the exploitation of old or the development of new iron-ore mines, but unless the ore supply is ample, its quality such as in demand, and the winning of the ore at low cost can be carried on for a term of years, the success of the enterprise is problematical.

The continued existence and evidences of prosperity of some of the plants located in sections of the country where the use of local ores is practically abandoned, and the late reconstruction of some of these plants to depend upon ores brought from distant points, indicate the importance of convenience to market and an established trade. The enormous output of iron ore from the Lake-Superior district, which is conveyed by rail from the mines to extensive shipping-docks, loaded on vessels which carry it to equally extensive receiving-docks, and again transported on cars for points of consumption from 300 to 1000 miles from the mines, demonstrates the growing appreciation of high-grade ores.

The extensive plants distant from ores or fuel, or both, which have been established near important commercial centers, and the concentration of allied industries at these points, evidence the general tendency of iron-production to become centralized in a comparatively small number of locations.

As the rapid increase of the population of the country changes the requirements of different sections, and consumers of iron and its manufactures multiply rapidly, deposits of ore yet unexploited await the local demand for metal, which will bring these ores and fuel for smelting them together. It is probable that some future industries will occupy territory which years ago or quite lately was developed in part by ventures which failed because they were in advance of the necessities of the times; the fact that some of

these earlier attempts proved disastrous may act as a check on improvements in sections which would sustain a considerable and increasing industry.

Deception as to the quantity of manufactured material required in certain districts has cost enthusiastic projectors much loss, and in some cases has condemned by premature efforts enterprises which would prove successful later. The apparent quantities of iron used often offers inducement to believe that a large local market exists, but these quantities when analyzed show that such varieties of metal must be made, and that so many minor industries must be established to transform the crude material into the merchantable shapes demanded that years elapse before new blast-furnace plants overcome the difficulties which await them.

The requirements of the steel-works for iron of special composition has been followed by foundries and mills making more rigid specifications; and this in turn has influenced the ores in demand by blast-furnaces. Progress in iron metallurgy has shown where economies can be introduced which reduce the fuel and labor per ton of iron made, and an appreciation of the relative values of different percentages of iron in ores has increased the demand for those which may be classed as rich in iron. Each year shows an increase in the average percentage of iron in the ore mixtures used in American blast-furnaces and longer distances covered by the rich ores in reaching points of consumption. It is probable that future advances may be in the direction of conveying fuel to meet these ores, particularly if the meeting points furnish good market facilities for the product, and that the use of lean ores will be chiefly in connection with great local advantages as to the other features which go to make up successful blast-furnace enterprises.

AMERICAN RAILWAY PROGRESS IN 1892.

By Thomas L. Greene.

THE new railroad mileage built in 1892 in the United States was something over 4000 miles,—very nearly the same amount as was reported for the previous year. With the exception of several important lines, to be mentioned hereafter, the new mileage consisted mostly of branches or short connecting links. In the review of railroad progress in 1891* the decline in building as compared with previous years was ascribed to several causes, financial and commercial. The refusal of investors to lend money even to old companies except under special circumstances, and the growing feeling in favor of keeping each system to its own territory, served to check new building except such as had already been contracted for or partly constructed. The condition of things which we found existing in 1891 continued during 1892, assuming even increased importance. It is noteworthy that out of a total of 4000 miles nearly one-half was composed of extensions to existing systems having 100 or more miles each, which were built under these exceptional circumstances and for the reasons stated.

The Great Northern heads the list for 1892 with the large result of adding 550 miles to its system in Montana, Idaho, and Washington; the present year will see this line completed to Puget sound. The project of building this new transcontinental road was formed several years ago. The Norfolk and Western, by building 112 miles, finished its line across West Virginia, thus completing its system of over 1500 miles from Norfolk, Va., on the Atlantic, and Hagerstown, Md., and Washington city, D. C., through the great coal-fields to a connection with the Ohio railroads at Columbus, and with Louisville and Nashville and the East Tennessee lines on the west. The Lehigh Valley also finished its line into Buffalo from the hard-coal fields of Pennsylvania, thus forming another road to the great lakes. The Chicago, Rock Island, and Pacific built across Indian Territory into Texas, and is credited with an intention of ultimately reaching the Gulf of Mexico. The Missouri, Kansas, and Texas, besides arranging for a road of its own into St. Louis from its main line at Sedalia, Mo., agreed to construct its

*Engineering Magazine, February, 1892.

long-needed connection into Houston, Texas, and toward the Gulf. The important northwest extension of the Chicago, Burlington, and Quincy reached Sheridan, Wyoming, last fall, and will be continued without doubt into Montana,—in time reaching the Pacific coast, if reports of surveys and purchases of terminal property are to be believed. The Sault Ste. Marie Company, owned by the Canadian Pacific and running from the Sault of Lake Superior to St. Paul, built during the year 80 miles of its extension toward Canada through North Dakota. The lines of this company will, when completed, allow the energetic Canadian Pacific to run its through trains from Montreal and New England to the Pacific coast via St. Paul and Minneapolis. All these railroads were extensions of existing systems, and from what has briefly been said about them it is plain that further building during 1893 will be necessary if the original plans are to be carried out.

Of the newer projects started during 1892 must be mentioned the new line between Detroit and Chicago, 150 miles built by the Wabash, giving that company the shortest route between those cities,—a line judged necessary by competent railroad men if the mileage of the Wabash already existing was to be managed for the best results. The new road, the Adirondack and St. Lawrence, running 130 miles through the Adirondacks or "North Woods" of New York State, forms a new line between the New York Central and Canada, and gives to tourists easy access to that great natural park. A new railroad, the Sandusky and Columbus Short Line, built for 100 miles in the State of Ohio between the cities named, is intended to give another outlet to the lakes and toward Chicago for the soft coal of one of the important Ohio fields. The conclusion to be drawn is similar to the lesson of a year ago, that our new mileage of the future will be built by existing corporations and that no one ought now to expect new lines in old territory except as parts of an old system.

But while, looking at the matter thus statistically, there seems little to add to the discussion printed a year ago in this Magazine, yet a review of the year just closed would miss its purpose if it did not take note of certain changes or rather tendencies which have developed and which must have an influence upon our opinions as to the future. The situation as regards railroad charges has become intensified. The dictum that railroads needed protection against unjustly low rates, rather than the shipping public against possible extortion, is more than ever true. The average revenues of

the leading lines per ton per mile, as shown by the annual reports, are in many cases the lowest in their history. Capital invested in railroads must receive the profits of ordinary investments in the long run, if the community is to be well served or to be permanently prosperous. The remedy usually advocated for unsatisfactory rates is that of pooling, and bills to legalize pooling contracts between carriers are before Congress, with the important proviso that the tariffs agreed upon by the roads shall first receive the assent of the Interstate Commerce Commission. Opinion among railroad men is not at all unanimous about pooling upon those conditions; some holding that the effect would be to give the rate-making power into the hands of Federal officials in the long run, while others think that such a plan would work well in practice, even if in part objectionable in theory. Another proposition is simply to repeal the section of the act to regulate commerce which prohibits pooling, leaving the railroads to arrange their non-enforceable agreements as best they can. Certain it is that among important groups of railroads the feeling that something must be done to check rate-cutting was never stronger. A part, however, of existing low charges on particular lines of traffic is due to commercial causes lying deeper than any theory of pooling. Wheat may serve as an illustration. Large crops for two successive years have yielded large quantities of grain which must find a market, particularly abroad. For reasons which we need not discuss, wheat during the fall and winter has been slow of sale in Europe, in spite of a continued decline in price. During the winter the elevators and storage houses and boats at all the interior and seaboard centers have been full. At regular tariffs the railroads could in the nature of things expect very little more wheat to be offered for transportation; yet their trains must run and their facilities must be used.

The temptation to stimulate shipments by a concession in freight rates is very strong, while to yield to it is only to obey a law of trade which we see working in every line of business. Still, some protection against commercial forces which unchecked tend toward insolvency belongs to the railroads of right, and should in some form be freely accorded them by law. As bearing upon the general question of profitableness in railroad-building, it is well to state—which seems to be hard of understanding on the part of some citizens—that the commercial conditions under which the greater part of our traffic is carried preclude any

material advance in railroad tariffs. The products of our fields and factories are moved by our carriers from producer to consumer only because they can be sold in the distant market at a profit over cost of production and freights. If freights are advanced and if local competition forbids a corresponding advance in price at the place of sale, the shipments will cease and the railroads will lose that much traffic. Continued far enough, such a policy would ruin the railroads as well as the producers. So in the lawyers' phrase, all builders of new railways may be said to be "affected with notice" that transportation tariffs in the United States are permanently low and that projectors must not base their calculations about the profitableness of new lines upon any hope of a large advance in general railroad charges, even under legalized pooling.

It is pleasant to note in this connection that the law courts throughout the country have shown a wish to protect railroad revenues against unjust legislation. The Supreme Court in the Minnesota cases struck the key-note with which the utterances of inferior courts since that decision have been in harmony. In Texas the Legislature created a State Board of Railroad Commissioners apparently with the intent of making their rate opinions final in effect, though nominally the act was drawn to meet the United States Supreme Court decision just referred to. Not expecting justice from a State court, the bondholders began in the United States court an action to restrain the Texas commission from promulgating certain tariffs said to be unreasonably low, and won their preliminary case. The railroad "right to live" has also been affirmed in other States. Those decisions, with a growing sense of partiality toward carriers under present low-rate conditions, have generally throughout the country kept the various legislatures from enacting any drastic measures affecting railroads. It is also proper to mention in passing that the authority of the Interstate Commerce Commission and the supposed efficacy of the Interstate Commerce Law to cure our transportation ills have both received rather severe blows during the year from various courts before which questions touching the act to regulate commerce were argued and by them decided.

Another point brought out clearly by the events of the year is the necessity for spending new capital for such improvements as will reduce operating expenses. Large expenditures to secure less cost per unit of traffic is the present condition of railroad success, particularly if we keep in mind the conclusion just drawn that rail-

road charges in the United States may be regarded as likely to decline rather than to advance materially. Economy thus becomes the main hope. A fact or two drawn from the history of a particular company will afford a good illustration. When the Chesapeake and Ohio railway was turned over to the present owners in October, 1888, it was in bad physical condition, and had but a small traffic. Its tonnage of course had to be increased, but the principal commodity in sight was soft coal, which had to be carried at very low rates. West Virginia coal had its price limit, say, in New England, while the mines were 400 miles from tidewater. Thus the maximum railroad charge was limited to $1.40 per ton for this distance, or an average of but 3.44 mills per ton-mile, perhaps the lowest annual average in the United States. Could coal be carried under such low charges at a profit? Yes, if enough could be got into each train to leave a margin over train expenses. Train loads were therefore the test of success. But large train loads involved reduction of grades and heavy rails, as well as good roadbed and firm bridges to bear the weight of the heavy modern locomotive required to haul a long train. All this demanded the free spending of money. This money was courageously and carefully spent; with the result that even at such low charges trains of coal at a profit move over the Chesapeake and Ohio at an expense so low per unit as to be reached only through the best modern railroad practice, costly though the requirements were.

The New York Central and Hudson River railroad is a road of very different character from the Chesapeake and Ohio, yet the same necessity was upon it. The annual reports tell in the statistics a story of progress. From 1889 to 1892 the average passenger-engine increased in weight 19,000 pounds, and the average freight-engine 36,000 pounds, by the purchase of new and powerful locomotives. The small and light freight cars in like manner were replaced by the best modern equipment. As a consequence the average train load rose from 225 tons in 1889 to 264 tons in 1892. What this means can be told by a theoretical calculation. If we divide the year's traffic in ton-miles by the average lading of a train in 1889, we find that, had the average of that year been also the average for 1892, freight trains must have run 2,500,000 more miles to carry the year's tonnage. Taking the mere movement cost of a freight train at 40 cents per train-mile, a low estimate (and by movement cost is meant only coal, wages of engineer, fireman, conductor, and trainmen, and repairs, excluding all other

operating expenses), the saving from that increase in train-loading is seen to be at least $1,000,000 for 1892 over the average for 1889. Although the calculation is theoretical, the results are probably underestimated. The example is a fine one of what can be accomplished even on an old road through the principle of spending money to effect economies.

Here again is an object lesson to civil engineers, to railroad managers, and to the investing public. The time for excessive cheapening in construction or in maintenance has gone by. If a railroad is expected to earn a profit for its owners under modern conditions, that end can only be reached by good and thorough work through the careful expenditure of capital, whether borrowed on bonds or taken from earnings. We have here also a hint for those concerned: if we deplore the small mileage of new road built during the past few years, we are not from that fact to infer that professional skill is in less demand. That demand has only changed its form. Talent is always required, but its direction has been turned toward improvement of existing transportation facilities rather than toward the creation of others wholly new.

The tendency toward consolidation among railroads has been observed during 1892; the reasons for it being much the same as those given in THE ENGINEERING MAGAZINE a year ago. A short road may find it increasingly hard to earn the profit of former years. At any rate such a short road is worth more to a system than to its owners if left standing by itself, so its absorption into the larger company is the wisest course; and certainly so far the public has been served better and more cheaply by such amalgamation. An example during the year is afforded by the New York, New Haven, and Hartford, which has absorbed the connecting lines of the Housatonic, the Naugatuck, the Providence and Boston, and the Providence and Worcester, all roads of local importance, on terms which grant to the original owners an increase in the value of their holdings. On the other hand the troubles of the unfortunate Richmond Terminal system prove that mere amalgamation of roads does not of itself give any surety for success. The Richmond and West Point Terminal and Warehouse Company was formed for the purpose of owning and combining the important roads of the territory south of the Potomac and east of Mississippi. Beginning with the Richmond and Danville, the system grew, but with obligations increasing faster than revenue, until in March a committee formulated a plan of reorganization which failed through lack of supporting opinion.

Since that time the struggle has continued, with charges and countercharges of dishonesty, but with little precise information made public and with the actual reorganization (assuming reorganization to be necessary) no nearer accomplishment. Time often heals railroad as well as other wounds. In this connection mention should also be made of the agreement among miners and carriers of anthracite coal, known as the Reading combination, formed to secure better prices for the hard coal sold for domestic use. The legitimacy and financial success of the combination are still subjects of warm debate.

It is well known that in England competition among the railways has taken the form of a rivalry in facilities instead of in charges for the service. At present in the United States we find both kinds of competition. Speed in the delivery of merchandise is of increasing importance, and so, in an even more marked degree, is speed among passenger trains. The scientific conditions which allow of high speed on railroads are now being studied as never before, and with the conclusions of mechanical and transportation specialists upon the subject the public is becoming familiar.* During the year the matter of high speed for passenger trains has received some experimental treatment. The unusually fast train on the New York Central, called the "Empire State Express," has been running regularly and demonstrating its practicability. That company has, as regards high speeds, some exceptional advantages. It has four tracks between Albany and Buffalo, and hence can give one track over to fast running without inconveniencing the regular service: for one of the important difficulties in practice is in arranging for fast and slow trains on the same track, without great delays in the movement of the regular service, freight and passenger, upon which the revenues of the company really depend. It is partly for this reason that the Pennsylvania is pushing the completion of its four tracks along its system. There is no doubt that the success of this New York Central train has stimulated the public demand for faster trains generally,—a result foreseen by many railroad men of other roads, who deprecated the new train on that very account, fearing that companies whose track equipment and signals were not good enough for fast running would be led in self-defence into putting on trains faster than their conditions warranted.

An example of another kind is the train service between Boston

*See the article in THE ENGINEERING MAGAZINE of February, 1892, already referred to.

and New York. The time required for this trip of 234 miles (figuring via the Boston and Albany railroad, the longest route) has in process of years been reduced by half-hours, until a year ago the usual express trains took about 6½ hours. In May a train was put on which made the journey in 5 hours and 40 minutes. Upon such old roads as those in New England it ought to be easily possible to run trains between Boston and New York in five hours. This would figure out about 47 miles per hour including stops,—not too fast for the railroads concerned, though such trains might require the purchase of a few specially-designed locomotives and involve some other preparations. Doubtless faster trains between those cities will come in time. It is very nearly the same distance between Washington and New York as between Boston and New York. Fast trains for a long time have been making this trip on the Pennsylvania in five hours. When the Baltimore and Ohio put on a similar train, the Pennsylvania acknowledged the competition by abolishing the extra fare hitherto charged on its limited Washington expresses. Although still carrying the majority of the passengers, the Pennsylvania has determined upon improvements which will cost several millions of dollars, and by which it is expected that the time will be reduced half an hour. These time-saving improvements include extensive changes in the terminals at Washington, by which delays in getting into the city passenger-station will be avoided, and expensive straightening of the line at points where there are curves or where roundabout tracks were originally laid.

Faster passenger trains naturally lead to the mention of mechanical road-improvements which sooner or later must accompany them. Signalling during the year has made progress, not only in the variety of devices invented or improved for interlocking and automatic signals with the least possibility of error, but also in the spread of the opinion that some form of blocking is a necessity, even on roads having but one track. In the very important question of the abolition of grade-crossings little has been done. So many wagon- or street- and railroad-crossings at grade exist that the expense of their removal is a problem which no one cares to face. Massachusetts enacted a law putting part of the cost upon the State at large and part upon the locality, with but a smaller part upon the railroad; but the compromise has not been elsewhere adopted. But if we are to have faster trains, grade-crossings must in some way be abolished. There is also no doubt

that the use of electricity as a motive power upon street and suburban surface railways has, in the cases where such lines cross the tracks of steam railroads at grade, added a new source of danger. The problem of uniform car-couplers and air brakes for freight cars is settling itself but slowly,—too slowly in the opinion of some, judging by the bills introduced in Congress to make their adoption compulsory. In general we may say that railroad progress in these matters resolves itself into a question of finance. The public cannot have improvements any faster than these are warranted by the carriers' revenues.

If any prophecy for the near future may be ventured upon, we may presume that our advance will be along the lines thus briefly described.

THE PRACTICAL VALUE OF LONG-DISTANCE TELEPHONY.

By Herbert Laws Webb.

A FEW weeks ago a business man in New York city telegraphed to the owner of a big poultry-farm in a small town in Illinois to go to Chicago and "meet" him at a certain hour on the long-distance telephone line that now places New York on speaking terms with Chicago. The Illinois farmer kept the appointment, and the two conversed together over the wires for half-an-hour. At the end of the conversation the Illinois man emerged from the telephone-booth, paid his $54 with entire satisfaction, and exclaimed with great glee: "Great Scott, I've just sold a hundred thousand chickens!"

This little episode "points a moral and adorns a tale." Such a text needs little expounding to a circle of business men such as comprise the majority of the readers of this Magazine. Take the first point. Correspondent No. 1 telegraphs from New York to correspondent No. 2, at some provincial town in Illinois, *to go to Chicago* in order that *he may talk to him.* Point the second. They talk for half an hour at a cost of $54. If a personal meeting had had to be arranged, they would probably have talked for several hours before coming to a settlement, the time spent in traveling by one of them would have been from three to four days, at a minimum, and the actual expense about $100. Point the third. A sale amounting to—I am completely ignorant of the wholesale price of chickens in Illinois or anywhere else—but say at least $20,000 was effected with great promptness and without the intervention of any middleman. Surely no better illustration of the business possibilities of the long-distance telephone could possibly be desired.

The service rendered by the telephone is in many ways distinct from that of the telegraph. The telephone brings two correspondents face to face, or rather mouth to ear. Question and answer, suggestion and modification, acceptance or refusal can be exchanged instantaneously, without any delay for writing, transmission, or delivery of messages. When a telephonic interview is completed, each correspondent knows exactly the position of the other, and there is no lingering doubt as to whether a message has

been misunderstood, or whether there is not some omission or error in that telegram that *might* have a slightly different meaning.

Although the telephone is to a certain extent the competitor of the telegraph, and from the superior facilities it affords in the way of free exchange of communication, rapidity, and secrecy, tends to divert the more important business from the telegraph circuits, yet it chiefly creates a business of its own, which, failing the telephone, would not be transacted by telegraph, but would necessitate generally a journey. This is the reason why the apparently high rates charged for long-distance telephone communication are not really expensive, and why a call over the long-distance telephone is always considered a matter of prime importance.

Not long ago a prominent capitalist belonging to a certain city in Pennsylvania visited New York accompanied by several associates in order to confer with an eminent New York banker and his associates on financial schemes of great scope. The meeting was held in the *sanctum sanctorum* of the metropolitan banker and was fairly under way when a clerk from the outer office announced to his chief that there was a call for him on the telephone. The leader of the visiting party, annoyed at the interruption, exclaimed: "Oh! look here; we have come all this way to discuss these matters with you, and we can't waste our time while you go out and answer calls on the telephone."

"Well," said the clerk, "but this is a long distance telephone call."

"O! well, that's another matter. Go ahead, by all means."

He felt that, while their conference should be proof against ordinary interruptions, a long-distance telephone communication had the right of way, so to speak, as it must necessarily be on some affair of importance.

It is not altogether easy to make a classification of the transactions for which the long-distance telephone is chiefly called into play. But as such a classification, even if incomplete, obviously gives the best idea of the business possibilities of long-distance telephony, it may be attempted in a general sort of way. The brokers probably form the largest class of customers belonging to any one business. They use the telephone wires in preference to the telegraph for two reasons,—the greater rapidity of the communication and the greater reliability of the service. Even against the promptest and most efficient telegraph service the telephone effects a gain in time. This is particularly exemplified in the Lon-

don-Paris line. The telegraph service between those two cities is a model one as regards despatch and efficiency, and a large number of direct circuits are kept constantly occupied. The average time of transit of a message from sender to receiver is about thirty minutes, occupied in checking, transmission, copying, and delivery. To save that half-hour the brokers use the telephone circuit and get instantaneous communication. Fully 95 per cent. of the business done over the London-Paris telephone line is supplied by the brokers, and the pay-station in the London Stock Exchange is in circuit almost all the time. Many are the dodges practised to prevent a competitor from getting at the line until after a certain time has elapsed, although the rules are framed so as to prevent these maneuvers as much as possible.

The reliability of the long-distance telephone service in America has become well known and appreciated. Any one who has frequent occasion to use the telegraph between points as far apart as New York and Chicago knows well enough that messages are often subject to long delay, and in the winter it is not uncommon for notice to be given at the counter that messages are only accepted subject to indefinite delays. The telephone circuits are, as a rule, more substantially built and better able to stand severe stress of weather than those of the telegraph companies, and this gives a reliability of service which attracts those to whom communication with distant points is a matter of absolute daily necessity.

A second large class of customers who have found long-distance telephony of great value and whose methods of doing business have been modified through the facilities it affords them are the large manufacturers. At one time it used to be the practice for manufacturing firms to lease a telephone line for a certain time each day, say from 11 A. M. to noon, giving direct communication between the head office in New York and the factory, perhaps somewhere up in Connecticut. (The same thing is still done in a slightly different way, as it was found that making a contract for the use of a line at a certain hour every day interfered with the proper distribution of the mass of the pay-station and subscribers' business among the different circuits.) The president or general manager of the company, with all his correspondence before him, speaks directly to the factory managers and heads of departments, and the effect is to practically place office and factory under the same roof, without sacrificing the advantage, among others, of the difference in price of real estate in city and country. The ultimate

result of such a utilization of telephone communication is, without going into details, that heavy or varied stocks no longer have to be carried in the city store-rooms, as even small orders can be transmitted at once to the factory and filled from the stock maintained there.

Other commercial transactions of a special nature, not occurring every day, form a class by themselves, and these increase steadily as the peculiar facilities afforded by long-distance talking become more widely known. An instance of this kind is the protection of a protested draft, a matter which could only have been satisfactorily settled by actual consultation and immediately; the telegraph would have been of no assistance, and the time available did not allow of a journey. Many other instances could be given of special emergencies having been fully met by means of the telephone that could have been met in no other way. These occur, of course, chiefly where the question of time is of vital importance, putting a journey out of the question, and where personal consultation, which the telegraph cannot give, is a necessity.

Another regular class of users is found among the legal fraternity, who, on important cases, hold quite long consultations with out-of-town clients and brother lawyers in other cities by means of the telephone. Still another comprises the large railway and coal companies, who use the long-distance telephone wires extensively for the transaction of important business in the handling of trains and heavy freight movements.

A point that is worth noting is that the long-distance telephone is used by the higher officers of big companies, by the presidents, vice-presidents, and general-managers,—especially where there are large departments in different cities,—for consulting among each other. As a general rule the office boy, or a clerk, is told off to attend to local telephone calls, but the long-distance messages go direct from chief to chief.

Probably one of the most striking effects on general trade of the firm establishment of long-distance telephony will be found in the curtailing of the middleman's field of operation. The talking wires bring consumer and producer into the most direct and closest communication possible without placing them face to face in the same room. It takes some little time for business men to become accustomed to any radical change in methods of communication and to perceive the advantages to be derived from new facilities, more especially as such facilities are not extensively

advertised or canvassed, but are left to a great extent to become known by experience among customers. Although the long-distance telephone really competes with the railway more than with any other system of communication, we do not find beside the railway advertisements in the daily newspapers an announcement of the points that can be reached by telephone at so much per five minutes' limited trip.

One or two of the instances given above show that the long-distance telephone tends to alter trade methods by suppressing the middleman in some form or other, and on the jobbing trade it is certainly bound to have marked effect. The large jobbing houses in the West maintain resident buyers in New York. It is the custom in the dry-goods and other trades to sell large consignments by auction. The buyer for a Chicago house can, when a sale is announced on short notice, inspect the goods, mark his catalogue, and call up the head of the house on the morning of the sale to let him know what there is going of interest to the house and receive instructions. As the minimum time for a letter and reply (by return mail) between New York and Chicago is five days, the advantages of the plan just described are very obvious, and although the New York-Chicago line has only been in operation a few months it has already become a practice. Any business man will see that there are many variations possible on this plan, and the illustration is a good one.

Of special uses of the talking wires between city and city many examples might be given, and a few representative ones may be selected, merely as pointers. A theatrical manager running two variety shows in towns about forty or fifty miles apart leases a private circuit between his two theaters. Occasionally something goes wrong at one or other, and a message goes over the wires for a performer to do a twenty-minute "turn" to go from A to B by the 1 o'clock train, to be returned to A later in the afternoon in time to take his turn on the boards there.

The wife of a busy man of affairs in Chicago spends a couple of months in New York during the winter to attend balls, opera, and theaters. The husband cannot spare the time to accompany her or to make constant trips to New York, so a long-distance telephone is placed in the hotel apartments in New York, and every evening husband and wife have a few minutes' chat over a thousand miles of wire to put each other *au courant* with their daily doings. This is an actual fact. If it had been related a few years ago in

one of Jules Verne's books, it would have been looked on as a pleasing flight of fancy on a par with the voyage to the moon in a projectile. The unpleasantness of family separations is certainly minimized when the voice can be carried instantaneously over a distance that gives the fastest train a run of twenty-four hours.

Many business men who have frequent necessity to travel some distance from headquarters call up their offices by telephone every morning from whatever city they may happen to be in, have their daily mail read to them, and dictate the replies. Surely "this so-called nineteenth century" has already solved the problem of being in two places at the same time. Not long ago the head of a New York house met with an accident in Boston which obliged him to lay up there for some weeks. He had a long-distance telephone circuit extended to his room, and during the whole time that the surgeons obliged him to keep still he was in direct communication with his office and managed to conduct his very extensive affairs to all effects as well as if he had been sitting at his own accustomed desk.

Of the use of the long-distance telephone system by the newspapers not much need be said, as newspaper men are quick to find out the most efficient means of serving their purposes. For a long time past they have used the telephone for reporting important out-of-town events quite freely. With a properly organized scheme of working, the telephone is admirably adapted for descriptive reporting of sporting events and has frequently been used in this way. For newspaper work, given certain conditions, the telephone is both quicker and cheaper than the telegraph. With an expert stenographer at the receiving end 100 words per minute can be sent over the telephone. Between London and Paris, for instance, long press messages can be sent by telephone for about one-third of the cost by telegraph. At one time it was the practice in the office of the *Times* for the parliamentary reports to be dictated by telephone from the reporters' gallery in the House of Commons directly to the compositors, who wore head telephones and set up the matter from the telephonic dictation. The strain on the compositors was found to be too great, however, and this practice, although it effected a great saving of time, had to be given up.

There is one field for the long-distance (using the term in distinction to the local) telephone which has not yet been opened up, and that is the providing of communication in sparsely settled agricultural districts, where not even telegraph wires have yet pene-

trated. The telegraphs follow the railways, and there are large tracts of country in the agricultural States where the railways make short cuts, leaving many of the agriculturists and planters without any means of rapid communication. In parts of Kentucky, for instance, a farmer may be obliged to make a day's journey by road to a railway station to ascertain if goods he is expecting have arrived, and often he returns empty-handed for his pains. The long-distance telephone system, as at present constructed and operated, could not be profitably employed in such situations, but *a* telephone could. The present long-distance telephone wires are very costly in construction, operation, and maintenance; they are necessarily so from the conditions under which the business is carried on. But in open country, where no inductive disturbances are to be feared, single-wire circuits would be quite efficient over distances of many miles, and could be constructed and equipped at a very moderate cost. The telephone has the advantage that it needs no skilled operator to work it. Although too many people even yet do not know how to use a telephone properly, very little instruction is required for an intelligent person to learn the "points" of the apparatus and use it with comfort to his correspondent and himself. All that is required, then, in such situations as I have referred to is a properly-equipped line, and the users will do the operating. What is called in telephone circles a "party" line—*i. e.*, a circuit having a number of stations on it so arranged that any station can call any other—would be the ideal arrangement for sparsely settled districts in need of some cheap method of rapid communication. In this large country there are many such districts, and here lies a virgin field for new telephone companies to exploit. In Europe the telephone, on account of the advantages I have referred to, is used to a considerable extent for providing communication where there is not sufficient steady business to support a telegraph office.

THE GLASS-MAKING INDUSTRY IN AMERICA.

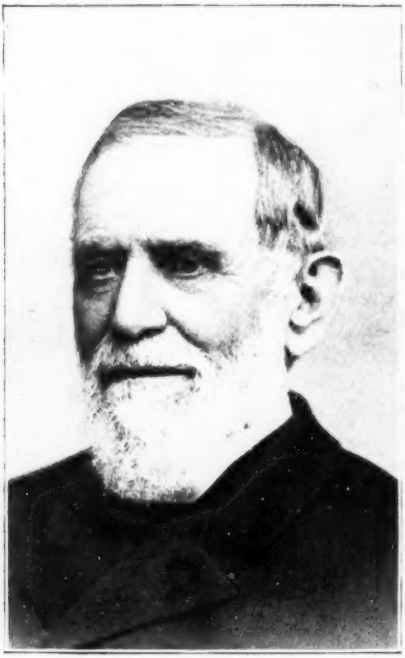
By R. M. Atwater.

THE necessity for glass bottles in the daily life of the early American colonies led very early to the payment of bounties to glass-makers. Window-glass could be imported at reasonable rates as ballast, but the case with bottles was very different. We therefore find that some of the earliest enactments in Massachusetts, Virginia, Pennsylvania, and New York, in the seventeenth century, related to glass-making. But these early attempts to establish the industry were mainly unsuccessful. In the eighteenth century, however, the making of bottles was established in a number of localities in which it is still in operation, although the works have all passed out of the families of the original founders.

These original factories were small affairs. The pot held about 500 pounds of metal and could be carried to the factory by one man holding it over his head. Now it is not uncommon to see pots weighing two tons and holding three tons of molten glass, or more than the output of a whole furnace of the old type, which usually contained six to ten pots. The fuel in the early furnaces was at first wood,—oak and pine, kiln-dried. As the wood began to fail various substitutes were adopted. In the West soft coal early proved a good fuel. In the East, before the war of the rebellion, North Carolina rosin was used with wood, and when this source failed, coal-tar from gas-works was used. The usual method was to dip a cord-wood stick into a barrel of tar and insert it in a round hole in the front end of the furnace. This produced an intense and an unequal heat that often caused the pots, when full of metal, to burst and precipitate their limpid contents into the mass of coals in the bottom of the furnace. Thence they emerged in a stream of black spongy metal on the factory floor, fit only for the ash-heap.

Mr. James M. Brookfield, late of the Bushwick Glass-Works, of Brooklyn, N. Y., was the first to use anthracite coal successfully for glass-melting by means of a forced blast. The use of this fuel was not successful, however, until the simple device was adopted of placing a layer of clinkers just above the grate-bars, which prevented their melting down at the critical part of the founding.

During the decade 1870–80 soft coal came generally into use in all the American factories. The style of furnaces did not show any material improvement until about 1870, when Dr. Burgin, of Philadelphia, introduced a Siemens' gas-furnace, but it was not a very successful construction, though still in operation. The Siemens' furnace erected at Lenox, Mass, built to melt cryolite into the hot cast porcelain, was a disastrous failure. The adoption of gas-furnaces, which during this decade had become general in Europe, was not followed among the American glass makers. The tariff and the abundance of cheap coal, followed by oil and natural gas in plenty, combined to satisfy them with the old order of things,—a very short-sighted policy, which they are now hastening to repair. In Europe furnace-construction is far in advance of the art in this country; and the best work done here to-day is simply the copying of the approved models of German and Belgian construction.



JAMES M. BROOKFIELD.
[The first to apply anthracite coal to glass-making.]

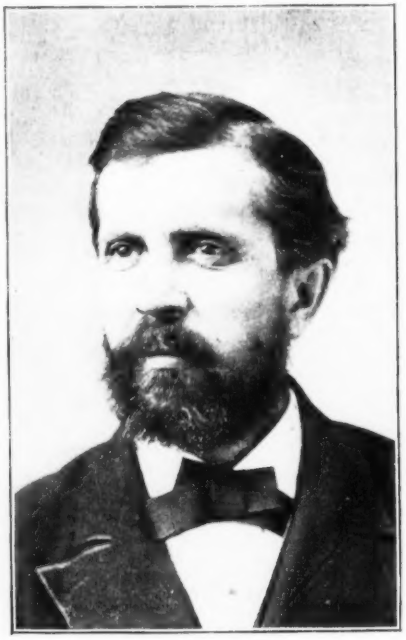
The molds used up to 1860 were almost entirely of clay, simply a round or square or concave hole in a block of fine burnt unglazed clay. This only shaped the straight part of the body, leaving the whole shoulder, neck, and lip to be formed by the unaided skill of the blower. This required the glass to be worked in a block of wood, and a large part of the leisure time of the blowers was spent hunting in the forests for block wood, "brasely pine" being the favorite. This brasely pine was an excrescence on the side of a yellow-pine tree caused by a bruise in

its earlier life. Later brass and iron molds came into use, stimulated by the desire of patent-medicine makers to advertise their trade-marks in more permanent ways, as bottles were kept and used long after their original contents were exhausted. At this day a brass or clay mold is a curiosity in a glass-factory. A mold of wood is used occasionally, or an iron shell lined with fine sawdust, in which the bottle while being blown is twisted. The mold is kept wet, and the heat of the glass generates steam which acts as a cushion between the glass and the inner surface of the mold. This gives a high polish to the bottle and avoids the seam which follows the joint of the two halves of the iron mold. The bottle blown without any mold —shaped in the air by the unaided skill of the blower—is of course the smoothest of any, but this is a slow operation and no two such can be exactly alike.

THOMAS WIGHTMAN.
[Owner of the General O'Hara Works, Founded 1797.]

The oldest bottle-factory in America is believed to be the works at Glassboro, New Jersey, now owned by the Messrs. Whitney, although the Dr. Dyott glass-works in Kensington, Philadelphia, operated at present by the heirs of the late Mr. Henry B. Benners, date from about the same year, 1770. At the Whitney works, in their branch factory in Vineland, New Jersey, is now being tried the mechanical bottle-blower which has been for several years in successful operation abroad. This does away with the exhausting labor of mouth-blowing, largely increases the product, and improves the quality at a greatly reduced cost. It

would be premature to assert that the glass-blower as we now know him will in the next generation be as obsolete as a clay mold, but there is little doubt that the mechanical bottle-blower, with compressed air, now has the call for a large variety of shapes, as for ales, minerals, beers, wines, fruit-jars, milk-jars, water-bottles,—in fact, bottles of any shape of greater than half a pint capacity that are commonly used nowadays in large quantities. The mechanical-blower is an English invention, though German and American inventors have entered the field as competitors. But the Ashley patent, developed by the able engineer, Mr. Joshua Horne, of Castleford, Yorkshire, is the device that has the most vitality of any now on the horizon.



W. L. LIBBEY.

[Manager of the New England Glass Company.]

The early American blowers in many cases made window-glass as well as bottles. The blowers of Boston in 1787 established a successful Crown-glass factory which lasted till 1820. From 1790 to 1800 window-glass works were established by General O'Hara near Pittsburgh, which have had a career of uninterrupted success to this day, and which are now under the control of Mr. Thomas Wightman & Co., of Pittsburgh. Mr. Wightman may therefore be considered the Dean of the Faculty of Window-Glass Makers, and he is to-day, at an advanced age, one of the most vigorous and progressive men in the business.

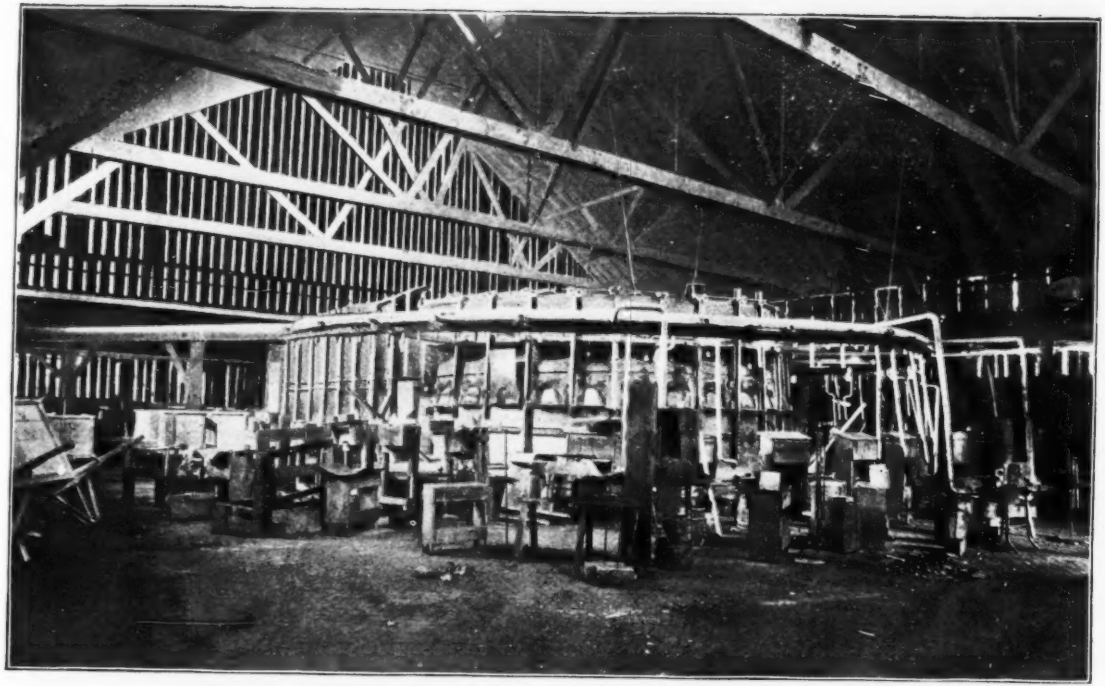
The finest window-glass works in America to-day are those of the Chambers' Glass Company, at Kensington, Philadelphia.

These furnaces are of the tank system and consist of enormous basins 100 by 20 feet and 4 feet deep, holding 600 tons of molten glass and accommodating 72 blowers, who work out about thirty tons of metal daily. These works are copied from the best Belgian models, and are of the Siemens' regenerative form using natural gas. They are adapted also to the use of fuel gas from Wellman gas-producers when natural gas fails.

The American window-glass is inferior to the imported, chiefly because less care is taken in the operations of blowing and flattening. There is absolutely no excuse for this inferiority, as our fuel and raw materials are better than the foreign, and our blowers and flatteners receive about treble the foreign standard of wages. It is simply an evidence of lack of discipline, which is the fault of the manufacturers, and the deteriorating influence of a powerful trade-union which controls the workmen.

CAPTAIN JOHN B. FORD.
[The "Plate-Glass King."]

It is not unlikely that the next development of the window-glass manufacture will be on lines similar to those met in bottle-making,—namely, the substitution of thin polished plate-glass for blown sheet. This thin plate is not at present made in America, the great works of the Messrs. Pilkington and the French works at St. Gobain and Stolburg having a practical monopoly of the business. But this glass can be produced by the most approved mechanical appliances at a cost but little above that of blown glass, and its great superiority for all practical purposes will commend it as soon



THE CONTINUOUS RECUPERATIVE TANK SYSTEM.
[The largest bottle furnace in America—Illinois Glass Company, at Alton—Dralle system.]

as it is available. It is familiar to all in the car windows of railway coaches. It is produced entirely by machines and low-priced labor, and offers at the present one of the most hopeful avenues for the profitable expansion of the business.

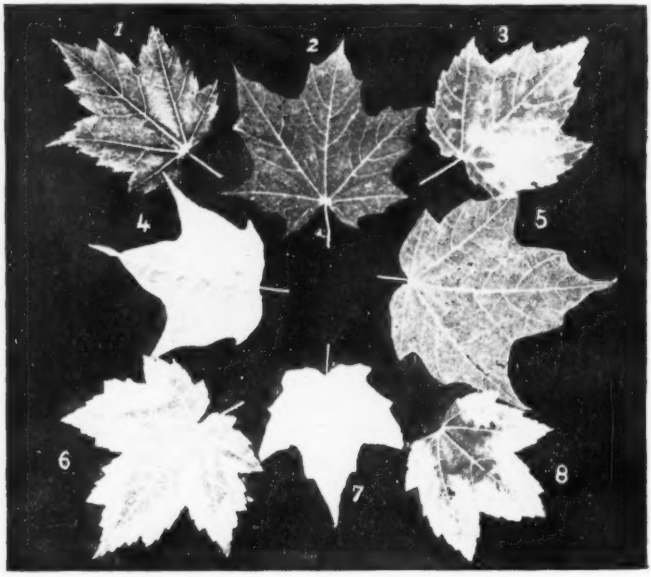
The class of ware known as flint-glass was first made in Pittsburgh in 1807. Mr. Thomas Bakewell purchased the works in the following year, and the factory has been in the possession of his descendants ever since, being now carried on under the style of Bakewell, Pears & Co. The product of the works was table-ware. The New England Glass-Works were started about 1812 at Cambridgeport, Massachusetts. From these works the highest grade of table-ware, cut-glass, and druggists' glassware were produced up to the present decade under the charge of Mr. W. L. Libbey. But the distance from fuel and the foreign methods of work adhered to when the American methods of unrestricted piece-work had been adopted by all other American manufacturers caused the business to become unprofitable and to be abandoned, and the works have been moved to Toledo, Ohio. The W. L. Libbey Glass Company have the contract for the Glass Factory at the Columbian Exposition. The Flint business now centers in the United States Glass Company in Pittsburgh for table-ware, and in the works of Whitall, Tatum & Co., in New Jersey, for druggists' and chemists' ware.

THOMAS GAFFIELD.

In the same department belongs pressed glass. Although a very old process, as may easily be seen at the Metropolitan Mu-

seum of Art, in the Jarvis and di Cesnola collections, yet to American glass-makers is due its practical and enormous development during the last twenty years. The glass-press is a finely-designed machine, and by it the cost of table-ware is greatly reduced, and the variety of shapes infinitely increased. The molds that produce these shapes are of great cost and variety. This art has been copied by the foreigners, and the best forms of American molds and presses are to be found in England and Germany, and their product is a close imitation of our best lines.

The making of chemical glassware in America was a direct result of the Philadelphia Exhibition of 1876. This glass is a triple silicate of potash, soda, and lime, and is also saturated with alumina. This last element gives it a dull appearance, but adds greatly to its refractory character. Up to this time the making of chemical glassware in America has not approached the high Bohemian or German standard, though America is probably the best market



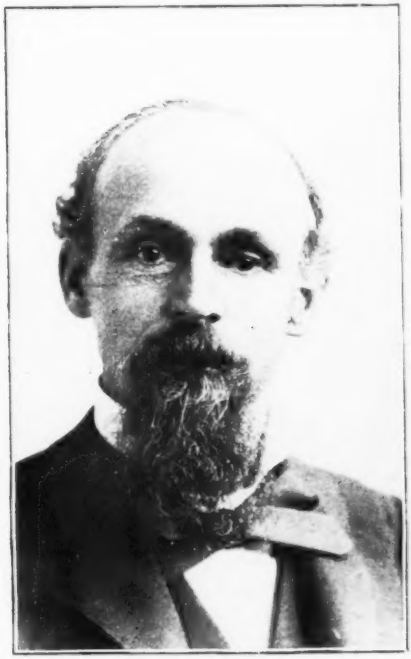
PHOTOGRAPHIC LEAF-PICTURES.

[The different shades produced show the comparative degrees with which the fresh green foliage, or the various autumn-tinted leaves, transmit the chemical or actinic rays:

1. Red and Yellow. 2. Yellow. 3. Green and Yellow.
4. Orange. 5. Green.
6. Red, Green, and Yellow. 7. Red. 8. Red and Green.

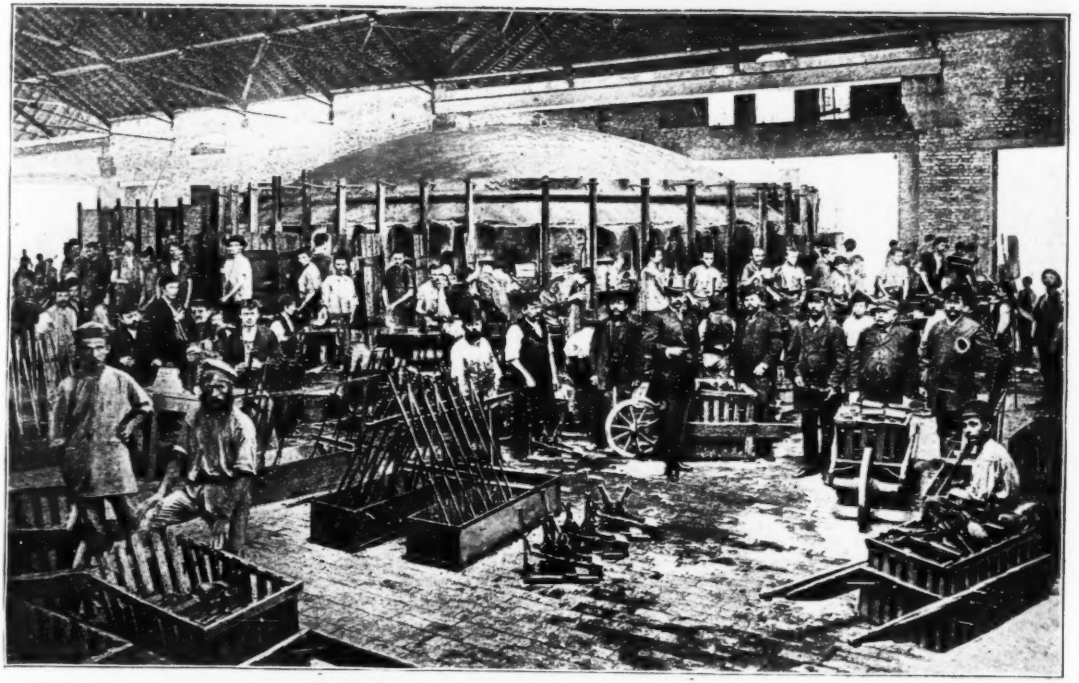
in the world for chemical glassware. In the development of low cost of making metallic aluminum it is possible that a glass may be produced that will have the flexible character of mica with the refractory nature of the best Bohemian glass.

The making of polished plate-glass in America was first successfully established by Captain John B. Ford, of the Pittsburgh Plate Glass Co. Although rough plates had been cast successfully in Lenox, Massachusetts, in 1870, the making of polished plate was a failure both at that place and at New Albany, Indiana, where Captain Ford was experimenting in connection with Mr. W. C. De Pauw. Though broken in fortune and over seventy years old, Captain Ford was not daunted by the failure of his early work, and in 1883 put new works into operation at Creighton, Pennsylvania, which were successful from the start. The fortunate discovery of natural gas in the vicinity of the works led to a profitable and fast-growing business, which now forms the largest plate-glass works in America, and nearly half of the total American product. Their capacity is 340 pots per day,—a pot producing about 200 square feet of polished plate-glass daily. The quality is fully equal to the French standard, and the foreign plate is now practically out of the American market. Captain Ford is emphatically one of the Captains of American Industry, and now at eighty-three years is as full of mental and bodily vigor as most men of sixty.



JOHN A. BRASHEAR.

The prosperity of the people of the United States is indicated



INTERIOR OF A GERMAN BOTTLE TANK FURNACE, AT DRESDEN.

in no clearer manner than in the adornment of their homes, churches, and public buildings. As America is preëminently a country of sunshine, the effects of colored-glass windows in architectural adornment are especially sought. In no other country, we believe, are these effects produced by body colors as largely as in our domestic work of the past ten years. Much of this work is of a high standard of beauty and taste, but it must also be allowed that much of it is of the Indian character that seems to characterize the childhood of native art development. This glass is pot metal, and the chief element in it is opal or milkwhite glass produced by mixing any of the refractory lime silicates, as phosphate or fluorid, in the ordinary batch. These held in suspense in the otherwise transparent glass produce the degrees of opalescence. Other colors are produced by various glass house pigments, too well known to need enumeration here.

HENK ROBERT DRALLÉ.
[Glass Engineer, Berlin.]

In this connection may be mentioned a fine piece of amateur investigation into the effect of sunlight on the color of window-glass, by Mr. Thomas Gaffield of Boston. This work is a classic in its way and exhaustive of the subject, and is recognized as complete and standard in Europe. It is perhaps the only American contribution to the physics of glass that has taken rank with the best European work. Mr. Gaffield based his conclusions on thousands of experiments, carried over a period of five years, and his conclusions may be stated as follows:

Any of the metallic oxids that color glass differently according

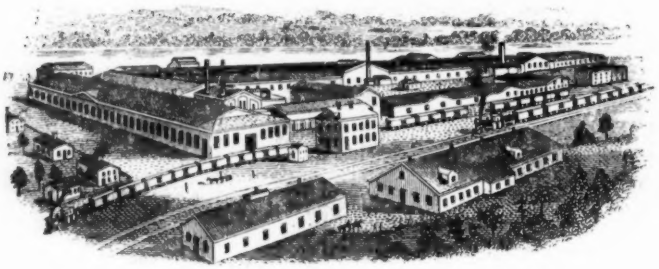


PLATE-GLASS WORKS AT CREIGHTON, PENNSYLVANIA.
[The first successful Plate-Glass Works, built by Captain J. B. Ford, for the Pittsburgh Plate-Glass Company.]

to different degrees of oxidation, as manganese, iron, and copper, are subject to change under the actinic ray and generally show a tendency to the higher state of oxidation. Thus glass on which it has been sought to neutralize chemically and chromatically the green tint of iron protoxid by the oxid of manganese—the so-called glass-makers' soap—is gradually turned purple in strong sunlight by the reoxidation of the manganese. Hence the aristocratic color of the windows of our colonial houses is shown to be simply the unmasking of a piece of glass-house sophistication. The color does not wash. Even where no attempt is made to "improve" the glass the green tint of iron was found by long exposure to assume the

THE OLD NEW ENGLAND GLASS COMPANY, CAMBRIDGEPORT, MASS.

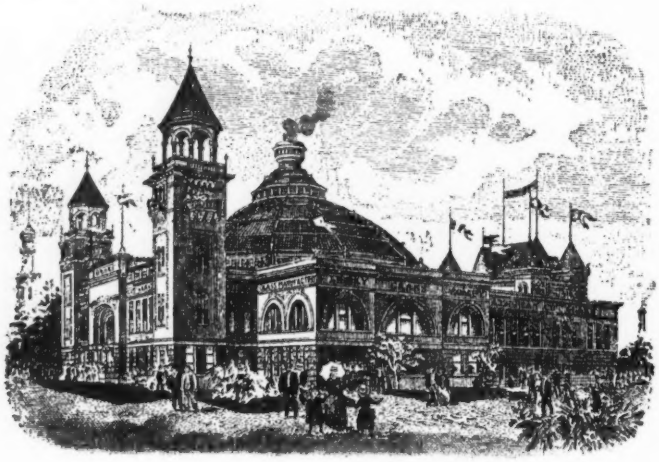
yellowish tint of the higher oxid. The colors of many of the old cathedral windows of Europe owe their inimitable mellowness to this gradual sun-painting.

The practical result of Mr. Gaffield's work was to demonstrate that the only way to obtain permanent colorless window-glass was to make it from the purest materials, that will offer the least possible field for this play of the elements. Mr. Gaffield's library of works relating to glass and his cabinet of specimens form the richest private collection in America, destined for permanent installation and a wider usefulness in the Museum of the Massachusetts Institute of Technology. His further research into the absorption of the chemical or actinic ray of sunlight in passing through colored glasses are of direct practical value to every photographer.

In this connection we may venture to praise the efforts of Chancellor Holland, of the Western University, Pittsburgh, in seeking to found a School of Glass Engineering in the center of the glass industry. The physics, the chemistry, and the engineering of Glass-Manufacture are fields of great value, both intrinsically and commercially. We may cite the remarkable results obtained by the experimental glass laboratory at Jena, founded by Dr. Schott and liberally subsidized by the German Interior Department. The result is that the field of optical glassmaking now is central in Germany as a new industry. The best thermometer glass is made from their formulæ. As this is written, word comes that this laboratory has produced a compound glass for steam-gage glasses that are practically indestructible. If the wealthy glass-makers of Western Pennsylvania would unite to build up such a course of instruction and such a working laboratory, it would be of immense value to the business. The glass technical schools of Bohemia have given Bohemia a monopoly of glass decoration, and, like the weaving schools of Chemnitz and Mulhausen and the ship-building school of Berlin, have transferred valuable industries to Germany.

It would not be proper to omit reference to Bohemian glass, although it is conspicuous only by its absence. The arts of painting, enameling, cutting, and engraving have been cultivated on such broad educational lines in the technical schools of Bohemia that it is a well-nigh hopeless task to seek to develop a domestic competition. We have not the artistic temperament that generations have produced in Bohemia. In a few establishments a high grade of English cut table-ware is produced, but this is the lowest grade of artistic glass and the least permanent, and even this has

failed to be of assured profit. Its cost is so greatly in excess of the varieties of pressed, etched, and sand-blasted imitations that it is more admired than purchased. The sand-blast invented by Mr. Tilghman, a genuine American contributor to the decoration of glass, is far more current and highly developed in Europe than in America,—so much so that the machines for American use are imported from England and Germany. A branch of the Bohemian work is the making of small articles, as the gas-lamp. In America this work is confined chiefly to the making of Homeopathic vials and syringes and electric-light bulbs, but for the best work in this branch, especially that required for apparatus for chemical and physical experiments, the work must be made abroad.



THE GLASS BUILDING AT THE WORLD'S FAIR.

The Venetian glass and bead work are untried fields in America, as is also mosaic glass. The most beautiful and permanent means of out-door mural decoration, well shown by the magnificent mosaic in the Berlin "Victory" column, stimulated the German chemist Schwarz to solve the secret of its composition. He studied with such thorough and intelligent method that the secret jealously guarded for centuries by the Venetian masters is now the possession of the world.

The making of optical glass in this land of telescopes has been earnestly tried by Mr. John A. Brashear and Mr. George A. Mac-

beth, of Pittsburgh, but so far the effort has not been successful. In the grinding of lenses the work of Mr. Brashear and the Clarks is unexcelled in all the world. The glass for the enormous number of lenses used in photographic cameras, reading-glasses, opera glasses, and spectacle prisms for physical research, and object-glasses for telescopic and microscopic purposes, are now, except in the very lowest grades, imported. The best market in the world is thus depending entirely on foreign sources of supply.

The American literature of glass is not extensive. The best work is the Census Report for 1880, by Mr. Joseph D. Weeks of Pittsburgh, to which we are indebted for many of the historical facts here noted. Mr. Charles Cohn of Washington city has prepared the two reports of the United States Commissioners to the French expositions of 1878 and 1889, and Mr. F. W. Gessner has published a volume of glass-house practice and receipts. If one should desire to study glass technically, there is no place so available as Berlin. Here he may read in four great libraries, where every standard publication of every language, in any form, is accessible. Here also are chemical and physical laboratories that specialize on glass and which have produced within the past five years the remarkable researches of Professor Weber and of Drs. Mylius and Forster. Here also is the home of one of the finest glass-engineers of Europe,—Herr Robert Drallé,—whose constructions of glass melting furnaces are the best in Germany. Within a few hours ride, after studying the fine collections in the three museums of Berlin, the student may study the finer collections at Prague, Vienna, and Reichenburg, and on his way he may make a detour through the glass refining districts of Bohemia, where the house-industry is developed to perfection. In another direction a few hours will bring him to the great bottle-works of Dresden and Semsheim, and the immense sheet-glass factories of Belgium, where M. Oppermann has brought to perfection the manufacture of sheet and plate glass.

Yet not to mention our own Metropolitan Museum of Art, with its four fine collections,—the Jarvis, the di Cesnola, the Bloomfield-Moon, and the Charret,—would be unfortunate. If any patriotic American wishes to take a wholesome lesson in the art of glass-decoration, let him, after walking through the sample rooms of the American manufacturers, visit these fine collections. He will see how far the commercial tests which govern American glass-making is from the art of our forefathers, and that we are as yet children in the most beautiful and most permanent of all the fine arts.

AMERICAN ANNEXATION OF HAWAII.

By T. Graham Gribble, M. Inst C. E.

IN the event of the annexation of the Hawaiian islands to the United States there will not be many mourners for the monarchy nor for the queen whose deposition is involved. The former has been for many years a caricature, and the latter has rendered it as mischievous as it has been foolish. Queen Liliuokalani has endeavored to dispossess the white people of the power which has gradually devolved upon them by virtue of their superior knowledge. Her revenues have been derived from the industries of the white people, her Hawaiian subjects contributing only a minute portion of the public funds. The attempt to place the ignorant and weak native as ruler over the white man who virtually owns the country was an act so dangerous and foolish as to merit the forfeiture of the crown.

In his civilization the Hawaiian is the child of New England's missionary labor. In his rapid extinction he is the victim of the white man's vices. He has gone under, not by slavery, or by the massacre, but by simple weakness. The Anglo-Saxon, acting in the main fairly towards the native, has come into possession of his country simply because he was able to use it to profit in a manner of which the native was incapable. If any foreign power is to own these islands, it should, upon every ground of right, be the one which has labored through its missionaries more than any other for the elevation of the race, and which by its treaty of reciprocity has created the present prosperity of the people.

With a population of half a million savages at the beginning of this century, now dwindled to about 35,000 and outnumbered by white people, the Sandwich islands have resisted annexation by the moral influence of American missionaries. First England and then France set covetous eyes upon Hawaii as a field for the introduction of rum and cognac, but the rulers, advised by the missionaries, have demonstrated the effects of civilization in the country, a spectacle which was at one time rightly termed "the romance of missions." Not from fear of each other, but in the mutual shame of so disgraceful an act as the destruction of this infant civilization, England and France have entered into a compact to preserve the

independence of the Hawaiian. The United States has never entered into this compact, but has repeatedly expressed disinclination for annexing outlying territory and cordial support of the independence of the islands. The desire for union with this country is about half a century old. In 1840 King Kamehameha III. for the first time placed his kingdom under constitutional government, voluntarily limiting his own powers and those of the chiefs, and establishing a legislative assembly consisting of a house of nobles and a house of representatives of the people. This action was favorably regarded in the United States, and a presidential message to Congress outlined the policy of this country towards the islands, which has been consistently maintained,—namely, that of viewing as an unfriendly act the attempt of any other power to take possession of the islands, at the same time preserving on its own part a cordial support of the native Government. At the same time the sentiment in the islands was strongly in favor of annexation to the States. The weekly paper published in Honolulu by Mr. J. J. Jarves, entitled *The Polynesian*, spoke of Hawaii as virtually an American colony and its "manifest destiny" that of absorption into the great development of American institutions.

In 1842 a French sloop-of-war visited the islands, and her commander made an attempt to bully the king into admitting French brandy with a duty of $1 instead of $5 per gallon. Armed sailors and marines paraded the streets, insulting the natives and freely displaying the French flag. The king made a dignified protest, setting forth his powerlessness to oppose force with force, but making his appeal to the justice of the French people. The sloop retired without anything worse than bluster. In 1843 an English war vessel, under command of Lord George Paulet, visited the islands upon an equally threatening mission. The British captain sent insulting messages to the king, ordering him to appear before him to revise the commercial arrangements between the two countries. The king replied in a manner worthy of his position, whereupon Lord George Paulet seized the country and held it for five months, enlisting native soldiers under the British flag. The king under protest, but succumbing to superior force, ceded the islands to the queen of England, at the same time making his appeal to the justice of Victoria. It is needless to say that the action of the king on both of these trying occasions was prompted by missionary influence. In July, 1843, Admiral Thomas arrived at Honolulu in H. M. S. *Dublin* and restored the islands to the king.

During the last fifty years American influence has increased until it holds a position in which it has no rival. The strictly moral influence of the missionaries, however, has become subordinated by the commercial influence, bringing with prosperity the vices of the white man. The spread of the vices of drunkenness and opium-smoking has been steadfastly resisted by the American missionaries, whose descendants to-day are the principal movers in the cause of reform, and from their positions of influence and authority in the country are the leaders in the movement towards affiliation with the United States.

The Hawaiian commissioners at Washington are "nobles,"—that is to say, they have been members of the upper house of the legislature. This class, which was at first composed of native chiefs, now includes storekeepers and artisans. The actual savage chieftain has long ago disappeared. The commissioners also represent very fairly the business interests of the country. Not one of them has any native blood in him, and here appears to be a possible mistake of policy. There are several natives and half-whites who have thoroughly approved themselves by business capacity and in the offices of the State for a position among the commissioners of Hawaii. The fact of their absence conveys the impression that the native sentiment was opposed to annexation, but this is probably not the case.

The Provisional government has undoubted possession of the islands, but any one conversant with affairs there can only look upon the recent *coup d'etat* as the only possible result of a struggle between the organized military force of the white people backed by the American marines and the shiftless, misled natives. The fact that all is quiet in the islands does not prove that a majority of the people have voted for or even approve of the abolition of the monarchy. That they would declare themselves for annexation if the case was clearly explained to them for their decision there can be little doubt. It is due to them, however, that they should be made to understand what benefits will accrue to them from annexation and how their present rights will be protected.

The latest bidder for the islands has been the Louisiana lottery syndicate. The specious offers of great public improvements were the bait which was swallowed by the queen's advisers. It should be made plain to the natives that the United States will carry out improvements and so bring money into the country, together with a steady growth of prosperity. The prospect of so utter a degra-

dation as that of becoming the headquarters of the lottery swindle should be contrasted with the benefits of union with the greatest power of the new world. Such arguments could not fail to carry conviction, and the Hawaiian people would by free vote, in harmony with American institutions, declare in favor of the change.

Personally the commissioners are as worthy a body of men as could be chosen to represent the best interests of the country, though they have not been elected by the popular vote, but are the leaders of a successful revolution. Mr. Thurston, the chairman, is a descendant of the Rev. Asa Thurston, a missionary to Hawaii in 1823. Mr. Charles Carter is a son of the late Hawaiian minister at Washington, and a grandson of Dr. Judd, the medical missionary who became minister of the interior under King Kamehameha III. Mr. W. R. Castle is a son of the financial agent of the early missionaries and a prominent lawyer; he has been president of the legislature for some years. Mr. W. C. Wilder is a brother of the late Samuel G. Wilder, who was one of the most valuable statesmen in the islands. During his tenure of the office of minister of the interior he carried out the segregation of the lepers on the island of Molokai. Mr. W. C. Wilder is the president of the principal steamship company in the islands. Mr. Marsden is, I believe, a planter on the island of Hawaii. The president of the provisional government, Mr. S. B. Dole, is also a son of a missionary, his father having been principal of the missionary college at Punahon near Honolulu.

Whatever may be the nature of the petition forwarded to Washington on behalf of the citizens opposed to annexation, it is quite possible that, unless the situation is properly placed before them for a decision, the majority of the native population would record themselves against the loss of their independence. It should be put fairly before them, and to the shame of white men it must be admitted that this has not been the case in the past. The natives have been humbugged more than once. At the election of the late King Kalakaua the people were overwhelmingly in favor of Queen Emma, the queen dowager. Kalakaua had been a government employé with a very unsavory record. Queen Emma was a good woman, but her sympathies were English and the predominant American sentiment was against her. The representatives were bought up, body and boots, by the white politicians who saw their way to using Kalakaua, and elected him. The people in a frenzy invaded the Government-house with clubs

and literally painted the walls red from the broken skulls of the faithless legislators; nevertheless the popular fury subsided. The white people held their ground, and the natives submitted to the force of circumstances. The only good result of Kalakaua's reign was the reciprocity treaty with the United States, but it can hardly be taken for granted that the same result could not have been attained with Queen Emma on the throne. Kalakaua's election was an outrage upon the nation from first to last. He deluged the country with rum, steeped it in opium, revived idolatrous and lascivious rites, and covered his frivolous expenditures on military and naval parades by a loan of $2,000,000. Inflated by bad advisers with the hope of making himself Emperor of Polynesia, he acted in so high-handed a manner that in 1887 the respectable men of the community rose and remodelled the constitution, limiting the king's power to a much greater extent than it had been before, and placing his estates in trust. The immediate cause of this revolution was the scandalous opium swindle. The king sold the license to one Chinaman and afterwards gave it to another. The first Chinaman died of a broken heart, and the king cleared about $100,000.

This Kalakaua was foisted upon the people from an apparently childish fear of English influence being exerted upon Queen Emma. It would be childish if there were no ulterior motive, because England has of late years left the islands very much alone. All the recent disturbances have taken place when there was no English war vessel in Honolulu. England is not so insane as to pick a quarrel with the United States about Hawaii. The ulterior motive of the Anglophobists is to stir up American enthusiasm, and doubtless the fact that the heiress presumptive Kaiulani is now being educated in England will be turned into valuable political capital by the present commission at Washington.

An American gentleman had for some time been trying without success to work up his railway scheme to Pearl river, and approached the managers of the street-railway syndicate with regard to its promotion. Receiving encouragement, he applied for a charter, but at once found that he would have to let the obnoxious Englishmen out. The latter, unwilling to be dropped, also applied for a charter. Up to this time the American's scheme had been scouted as visionary and ridiculous. Directly it was known that the Britisher was in the field, the American floated on to success upon a torrent of Anglophobism.

The Oahu railroad referred to is one of the most important works in view of American annexation. It is combined with a land company for developing the district of Erva, which borders on Pearl harbor. The United States Government have an agreement with Hawaii under which it possesses the exclusive right to create a naval coaling-station there. The work required to be done is the dredging of an entrance to the beautiful coral lagoons, which are of sufficient capacity to receive the whole American fleet. The cost of this work has been variously estimated at from about $300,000 to $2,000,000. It is probable that the former figure is the more exact, but the value of the harbor when finished would justify a much larger outlay.

The next great work which is required for the development of the islands is the submarine cable from San Francisco. If the islands were in British occupation, the cable would be at once laid, and thence on to Australia ; but to the United States government it would not be of equal value, as being nothing more than a link with a small and distant dependency.

The sugar industry and the labor question as affected by annexation are points about which it is difficult to make predictions. Twenty to thirty years ago the infant sugar plantations of Hawaii were successfully operated without any favors, and with the rudest kind of machinery. When Judge Austin introduced fluming cane at Onomea plantation about twenty-five years ago, they had been hauling it to the mill with bullock- or mule-carts, buried up to the hubs in the soft soil, continually moistened by the heavy Hilo rains. Their machinery was of the roughest type, but they made a living for the simple reason that they paid only $3 board per month for labor, or $6 without board. The native had his taro-patch, which gave him all the food he wanted for the year, and his clothing did not trouble him much. Now labor costs about $1 per day, and although they have the finest possible machinery, some of the plantations are not paying their way. It cannot be expected that the United States will extend the beet-sugar bounty law to cane-sugar in Hawaii, and the islands must therefore reckon on continued competition with Cuba on an even basis and with American beet-sugar fostered by bounty. The question will be whether annexation will not enhance the labor difficulty. There is at present a large Chinese population in the islands. This comprises the only imported labor which cannot leak away to the United States. Portuguese from Madeira, Japanese, and others imported at great expense for plan-

tation work all look upon the islands as a stepping-stone to America, where they hope to get from $1.50 to $2 per day. Unless some special clause be inserted in the annexation treaty these Chinamen would also be free to come over to San Francisco. At all events the effect of annexation would be to bring the price of labor in the islands to a close level with that of the United States. Hawaii is adapted to Coolie labor. She can never flourish on the protected high-price system of America, because she has to compete with Coolie labor in other countries.

The plantation most recently started has been on Kauai, in an exceptionally fertile part of that island. It is partly owned in England, and the first crop has been taken off this year. There is still considerable land suitable for sugar, but there is not much disposition to take it up. It can hardly be taken as proved that it is owing to the unsettled state of the government. This Kauai plantation was started just after the last revolution. It is the labor difficulty more than politics that keeps back the development of the islands. The Chinaman is of all others most suited to supplant the native. He comes to stay, the others to return or to go on to America. Even the Japanese is compelled by his government to set aside a portion of his wages for his return. The Chinaman has taken the unhealthy swamps and turned them into luxuriant rice-fields. He now controls the second industry of the country. If allowed to come in freely, he would soon increase the population many fold and bring down the price of plantation labor. The difficulty is that the Chinaman is not content with raising cane and rice; he makes the Hawaiian's clothes, and runs dry-goods stores, livery-stables, and every other industry he can lay his hands on. Attempts have been made repeatedly to restrict him to agricultural pursuits, or else to send him back to China. One bill was introduced into the legislature to restrict him to plantations, but some wealthy Chinamen got together and bribed the Hawaiian representatives to throw out the bill. The white man now owns the islands and is afraid of being crowded out by the Chinaman. We can do no more than state the difficulty; the solution will gradually be arrived at after the manner of a compromise. Improvements in machinery and better transportation facilities will continue, cheapening the manufacture of sugar and implements for field-work. Labor will have to be treated on lines different from those pursued in this country, and an equilibrium of population will be reached at a lower level than in the earlier history of the islands.

The idea that annexation will be followed by an immediate rush to the islands, as to some newly acquired Indian territory in the United States in the past, is probably a mistake. Emigrants from the United States do not rush into competition with Chinese or Japanese coolies. There is very little opening for small traders and artisans; barely a living for those who are there now. The land has fallen into the hands of a few, who have become rich and can afford to hold it. There would be opportunities for small planters of coffee, quinine, ramie, fruits, etc., if the government were to use the land it holds in that manner, but where it has commenced this policy it has not met with eager response. The Portuguese, who are the best people for small farming, would rather get away to the Pacific coast than take up land in the islands.

The last but not least important work to which we will allude as essential to Hawaiian progress is the railway on the island of Hawaii from the port of Hilo, near the volcano of Kalauea, to Waipio, a distance of about seventy miles, entirely through sugar-plantations. This railway was one of the schemes included in the programme of the Louisiana lottery proposal. It is so important an enterprise that the late Samuel G. Wilder literally sacrificed his life in the attempt to carry it out. First as minister of the interior, and afterwards as president of the Kohala railway, he visited Boston and London in an attempt to raise the money to build it. Although a difficult piece of location, this railway has been shown to be entirely feasible. It would, besides greatly facilitating the transportation of sugar, develop the port of Hilo and open up a large quantity of land to the cultivation of coffee and fruits.

In conclusion, the fact may be emphasized that, although Hawaii would not be to the United States what it would have been to Great Britain in her scheme of imperial federation, it will be of great strategic importance, and it is not to the ex-queen but to the Hawaiian people that this government should make some adequate return for the possession of such a valuable naval station. If the United States will do at least as much for the islands as the Louisiana lottery proposed to do, and will so represent the case to the people, there would be an overwhelming vote cast in favor of annexation, and the transaction would be accomplished in a manner more in harmony with American ideas than if carried out with a commission not elected for that purpose by the people, however worthy in itself the commission may be.

ELECTRICITY.

Conducted by Franklin L. Pope.

AT a recent meeting of the Manchester (England) Association of Engineers, an important paper was read by Mr. B. W. Thwaite, in which he advocates the scheme of generating power on a large scale by means of gas-engines in the South Yorkshire coal district, and transmitting it to London. Careful estimates by Mr. C. E. L. Brown, formerly of the Oerlikon works of Switzerland, who has been remarkably successful in electric power-transmission work, and is therefore excellent authority, show that 10,000 horse power can be delivered in London at less than 3 cents per kilowatt, and yield at that rate 7 per cent. on the investment. All the principal manufacturing centers in England are easily within electrical reach of the coal-fields, and hence it is not necessary to wait for towns to grow up to use the power, which is one of the objections to the Niagara enterprise. Compound interest on the cost of a large undertaking amounts sometimes to a great sum while waiting for returns to come in. On the other hand, a careful computation will probably disclose the fact that it will cost less to transport the coal from South Yorkshire by railway or canal to a point just outside London, and there convert it into electricity, than to transmit the equivalent value of electrical energy by wire over the same distance.

THE legislative Solons at Albany have begun their attacks upon the "trolley" system of electric railway propulsion, apparently in blissful ignorance of the fact that it illustrates but a transitory phase of electric railway development, and must needs be endured at least until a better system can be devised for its replacement, which may occur sooner or later hereafter according to circumstances. A Brooklyn member has introduced a bill making it unlawful after the passage of the act to use electric "contrivances" above ground for the operation of street-cars in cities, and directing the subway commissioners and commissioners of public works to place all such "contrivances" under ground before December 31, 1893. If the use of the trolley system could, under the provisions of this act, be summarily discontinued for about one week in all the cities of the State, we think the author of the bill, if he could be reached, would be got into proper condition to be placed under ground at a period considerably anterior to that mentioned in his proposed act.

DR. J. B. WILLIAMS has investigated the non-conducting properties of the glass used by the electric companies in this country for insulating their aerial lines. He finds, as perhaps might have been expected, that the richer in silica the composition of the glass, the higher is its surface resistance, and therefore its specific resistance. Dr. Williams suggests that a double-bell insulator, having its inner bell formed of a glass having a large proportion of silica, would prove particularly valuable for lines carrying currents of high pressure.

THE experience with underground electric conductors in New York has now extended over a sufficient length of time and area of territory to enable an approximate comparison to be made with the overhead system, or rather lack of system, for which it has been largely substituted. It seems to be pretty conclusively established that a commercially satisfactory system of underground wires has resulted from the work of the past five or six years; that this is far less liable to interruption than any overhead system which can possibly be devised, and that it is less dangerous to human life; while, on the other hand, its first cost is enormously greater,—certainly not less than five or six times as much for a given number of points of service; it is

in many respects cumbersome and inconvenient, lacking the flexibility and adaptation to different conditions of the overhead system, while its cost precludes its extension to sparsely settled districts, which must either be reached by aerial wires or not at all. The mere subway rental of the wires in the Fifth avenue, New York, is said to amount to about 32 cents per lamp per night. The excessive cost of the telephone service in New York is in great part due to the same cause,—the enormous expense of the underground conductors now used throughout the central districts of the city.

WHILE it is not probable that electric-railway conductors are in any way responsible for the apparently unusual number of fires which have occurred in Boston during the past few months, it is certain that the network of overhead wires in the narrow and crooked streets of the old part of the city sometimes constitutes a serious hindrance to the firemen in the discharge of their duties. The West End Railway company now maintains a specially trained and equipped emergency force, which is called out by each alarm, and accompanies the city fire department. A crew of five or six men goes with a light wagon, equipped with extension-ladders and appliances for cutting and rejointing wires. The trolley- and guard-wires are frequently cut and got out of the way, and the electric feeders looped around the gap are connected, while the firemen are reeling out their hose and making connection with the hydrants.

THE inauguration of long-distance telephone service between Boston and Chicago took place on February 7, on which occasion Governor Russell of Massachusetts formally opened communication by exchanging compliments with the officials of Chicago, in the presence of a large number of invited guests. The electrical conditions were really admirable, and conversation was carried on with the utmost ease. While the cost of telephonic conversations at these long distances may appear high, it must not be forgotten that the correspondents are enjoying for a limited time the exclusive use of a plant which has cost an enormous amount of money. Moreover, the amount of matter that can be transmitted by telephone under favorable conditions, in the space of the five minutes allowed, is surprising. By the aid of a stenographer 600 to 800 words have been got through during that time, which is cheaper than telegraphing, to say nothing of the obvious advantages realized in many cases. The future development of long-distance telephony is certainly an interesting subject of speculation.

THE electrically-operated elevated railway in Liverpool, a brief description of which has heretofore appeared in these notes, was formally opened for business on February 4. The trial trip was made at a speed of 22 miles per hour. Detailed accounts of the results attained in the operation of this line will be awaited with much interest by the electricians of the United States, inasmuch as a successful solution of some of the problems involved in the Liverpool undertaking will throw a good deal of light upon some of the most pressing ones in our own country.

THE Chemical Society of London has installed the electric light in its house. Considering that a large proportion of the members of this organization must be pecuniarily interested in the manufacture or sale of gas, or of the by-products arising therefrom, and that the chemical processes by which gas is manufactured might be expected to be viewed with favor by professional chemists, this action may justly be regarded by electricians as a valuable testimonial to the merits of the new illuminant.

IN a work recently published Professor Oliver Lodge points out that progress in the direct manufacture of artificial light is now going on in two different directions. One of these is by attempting to construct mechanism, or to discover principles, capable of causing or maintaining electric oscillations of the desired frequency; the other is to render available the properties of certain molecules which are disturbed

and thrown into vibration by comparatively slow electric oscillations, and are thus caused to phosphoresce. It is difficult as yet to forecast the result of these researches, but there can be no doubt that they are likely to prove of vast importance at no distant day.

GREAT progress has been made during the past year in the construction of non-synchronous electric motors adapted to be operated by the alternating current. There exists a large field for the application of these motors, especially in cases where light and power must be supplied together in the simplest manner possible. A recent motor of this type, devised by C. E. L. Brown, a well-known Swiss electrical engineer, appears to be in advance of many of the existing direct-current motors in respect to safety in operation, and in the amount of attention requisite from skilled employés, while quite equal to it, weight for weight, in output speed and commercial efficiency. For power distribution pure and simple, where the question of lighting does not have to be considered, the multiphase type of motor will doubtless continue to grow in favor.

THE old proverb that "figures will not lie" has been amended by some modern philosopher by adding the supplementary qualification that "liars sometimes figure." The opponents of the electric railway are deriving great comfort from a carefully prepared statement which appeared in the New York *Evening Post*, in which an attempt is made to prove that the introduction of electricity on the lines of the West End Company of Boston has proved, in a financial sense, a disastrous mistake. It is shown that since 1888 the capital stock of the company has increased from $29,733 to $69,442, and the operating expenses from $14,190 to $20,114 per mile of road and from $2586 to $2742 per car per mile, but the writer carefully omits to state that the number of passengers carried has also increased from 84,843,722 in 1889 to 126,310,781 in 1893, and that during the same period the ratio of expenses to earnings has fallen from 82 to 76 per cent. and the cost of transportation per passenger from .0411 to .0380 cents, while the net income per passenger has increased from .0093 to .0120 cents. Much stress is also laid upon the great increase in the number of accidents. This is an unavoidable result of increasing the number of cars and the speed of running, but, as not one of the victims was either killed or injured by electricity, it is not altogether fair to charge them all to the account of the "deadly trolley." A system which largely increases the number of passengers accommodated, and at the same time materially augments the net income per passenger, is likely to hold its own in spite of newspaper denunciation.

MR. W. H. PREECE, in a communication to the British Association, states that during an electric storm the equipotential planes upon the earth's surface appear to be perpendicular to a line joining the center of the earth and the center of the sun, inasmuch as telegraphic lines running in this direction are found to experience the most serious disturbance, while those running at right-angles to the equipotential planes are not deflected. Those which experience the maximum disturbance in the forenoon are free from the influence in the evening and *vice versa*. The maximum current intensity observed by him exceeded 45 milliampères.

THE fundamental patent of Alexander Graham Bell, covering the transmission of sounds by means of an undulatory current of electricity, expires early in the present month, although his supplementary patent covering the details of construction of the commercial magneto-telephone runs until the end of January next. The American Bell Telephone Company, however, own another patent issued to Emile Berliner in 1891, after a delay of many years in the Patent-Office, which is claimed to cover the essential principle involved in telephonic transmission by varying a battery current by pressure upon contact points, a method which in the present state of the art seems necessary for all exchange and long-distance work. It has recently been

announced that a suit to annul this last patent has been instituted by the Attorney General of the United States, with the intent to make the whole business free to the public so far as patents are concerned. A similar suit to repeal the original Bell patent has been pending in the courts since 1887, and from present appearances bids fair to outlast the patent for many years. The principal object of these suits appears to be more especially for the purpose of providing a permanent maintenance for such attorneys and experts as may be fortunate enough to become connected with them. In any event, after January next, the magneto-telephone will become public property, and for very many purposes will be found a most efficient and admirable instrument.

A NUMBER of young men living in different parts of the United States have organized an Amateur Electrical Union, the aim of which is to encourage and facilitate the systematic study of electrical science among young persons whose tastes lie in that direction. Any one desiring to become a member may obtain full information from G. C. Minor, Chesapeake and Potomac Telephone Co., Baltimore, Md. Such an organization, if judiciously conducted, ought to become a source of great benefit to its members, and it is to be hoped that the scheme may meet with success.

THERE are over 100 miles of electric street railway in Cincinnati operated by the double-trolley system. This system possesses some advantages, especially in its avoidance of defective insulation and interference with telephone lines, as well as the diminished liability of producing fires by crossing with other electric lines. On the other hand, the complication of overhead wires, especially at important junctions, is somewhat objectionable. The system does not appear to be used to any extent in other cities.

IN no department of the electrical field is more rapid and satisfactory progress being made than in the application of this agency to the many and varied details of mining operations. In the electrically-operated mine there are no shut-downs; no choked pumps or broken and bursted pipes. The endless catalogue of mishaps which occur, especially in cold weather, in a mine operated by steam-power find no parallel in the electrically operated mine.

IT appears at first sight a singular paradox, but it is nevertheless a well-ascertained fact, that the cost of producing a given amount of light by the combustion of gas in the ordinary way is considerably greater than the cost of an equal amount of light when derived from incandescent electric lamps, fed by a dynamo which is in turn driven by a gas-engine. This fact would seem to indicate that a profitable field of industry might be developed in the direction of supplying small plants for domestic lighting, consisting of a combination of a gas-engine and a dynamo capable of supplying say from 20 to 50 lights, more or less.

IN the long-distance telephone service 30 or 40 miles of "emergency cable" are always kept on hand for immediate temporary repairs of any line which may be disabled by a fire or a storm of unusual violence. This cable comprises seven pairs of waterproof insulated conductors, laid round a core of stranded steel wires, and covered with a protecting jacket of tape saturated with preservative compound. It is stored on reels holding 1500 feet each, which can be put on a wagon or into the baggage-car of a train almost at a moment's notice. The cable is very strong, and can be stretched over housetops, along the stumps of broken poles, or on fences, or even upon the ties of a railway, without sustaining any injury.

A SINGLE mile of submarine cable offers as much obstruction to the transmission of telephonic conversation as twenty miles of pole line. This is due to the greatly enhanced effects of induction. Paper insulation is largely free from this objection, and this has led to its extensive employment on subterranean lines.

MR. L. H. MCINTYRE, in a recent report on improvements in electric traction, made to the New York Street-Railway Association, spoke highly of the results which had followed the introduction of the iron-clad type of motor for electric-car service. Great improvements have also been made in the trucks and methods of mounting the cars, so that it is now possible to carry a 28-foot car-body on a four-wheel truck without undue oscillation. There has been a general improvement in the details of overhead electric-construction. Stiffer poles and stronger span-wires have been introduced, with better insulation and more elegant and tasteful curve-fittings, so that the general appearance of the structure in the street is far less objectionable than formerly. In the central- or power-station equipment, the modern tendency is distinctly towards the use of large multipolar dynamos, dispensing with counter-shafting and other complications. The general type of station seems to have become fairly well settled, although considerable difference of opinion still exists as to the most desirable size of power units.

THE Chicago Telephone Co. are engaged in constructing what is intended to be the finest and most complete telephone exchange in the world. It is expected that more than 600 instruments will be required within the enclosure of the World's Fair, besides at least twenty-five pay-stations. The completion of the long-distance line will enable direct conversation to be had between Chicago and the principal cities, a distance of nearly 1000 miles. This line was tested on October 19th with most satisfactory results, the mayors of New York and Chicago being enabled to exchange verbal congratulations. The line will soon be thrown open to the public.

THE Union Railway Company is now engaged in equipping an electric street-railway line in the annexed district north of Harlem river, in New York city, which runs for nearly its entire length directly underneath the Suburban Elevated Railway. Advantage has been taken of this circumstance to utilize the Suburban structure for the support of the electric conductor of the street-railway. In this way it is completely protected against snow and sleet, as well as from possible contact with other wires. This might be done in many other parts of the city with great advantage and without real objection were it not for the insane outcries made through the newspapers by adverse interests.

AFTER the exhibitors of electrical apparatus at the World's Fair have completed their plans for an exhibit costing some millions of dollars, and have done a large amount of preliminary work in carrying out their plans, the management have issued an announcement that the fair is to be closed at 7 P. M. each day. It is difficult to imagine any adequate reason for such a decision as this, and we hope the electrical exhibitors will emphatically protest against it, even to the extent of refusing to exhibit if the determination of the managers is insisted upon.

THE electric search-light on the summit of Mount Washington, N. H., has been completed and installed, at a reported cost of $7000. The movement of the light is controlled from the foot of the tower by electric motors. A 15-horse-power engine is sufficient to furnish the power. Telegraphic signals flashed by the light have been readily observed and interpreted at Portand, Me., a distance of about eighty-five miles. The intensity of the light, as concentrated by the lenses, is estimated to be about 100,000 candle-power.

OBSERVATIONS of lightning made during the past summer at the Blue Hill Observatory near Quincy, Mass., aided by photographs, show conclusively that discharges occur in all directions; from cloud to cloud, and from cloud to earth and conversely. In the majority of cases, however, the discharge is from cloud to earth.

IT may be worth while to note that the unburned stubs and ends of arc-light carbons are said to make an excellent fuel, especially if mixed with anthracite coal.

MECHANICS

Conducted by Leicester Allen.

REGARDING screw propellers something was said in this department in the January number, and some editorial remarks upon this subject were quoted from *The Engineer* (London). That the opinions of our transatlantic contemporary would not be accepted by American engineers without some demur was intimated. This intimation has been shown not to be without foundation by the receipt of a letter from Mr. H. C. Pearson of Ferrysburg, Mich., an engineer and the author of a work entitled "Navigation for the Lakes,"* a treatise adapted to the special use of inland lake navigators, whose needs in a work of this kind differ materially from those of ocean navigators, owing to the labors of the United States Lake Survey. This survey, as stated by Mr. Pearson, "having determined the coördinates of place for all the lighthouses on the whole chain of lakes," and made the results of the survey accessible to every shipmaster, has thus greatly simplified the labor of navigation. This, in connection with the adoption of standard time, which Mr. Pearson justly characterizes as "the greatest aid to navigation on the coast and the lakes that could by any means have been devised," obviates the necessity for the use of the chronometer as in ocean navigation, and renders the lead, log, and compass about the only instruments now needed for lake navigation.

Mr. Pearson must therefore be regarded in the light of an expert, and his criticism is worthy of attention. He says: "*The Engineer* is correct in supposing only about 88 per cent. of the power of the engine is delivered to the wheel; but it is badly out when it gives us to understand that 'blade-area' is the chief factor in the construction of the propeller wheel. It should know that blade-area is of small account as compared with disk-area: also that of the amount of power delivered to the wheel, only that component which is parallel to the line of thrust is available for propulsion, and that blade-friction must be paid before this projection is made." Had Mr. Pearson read the entire article quoted from, and not merely the passage quoted, he doubtless would have seen that *The Engineer* meant the same thing by the term "blade-area" that he means by the term "disk-area." At least that was our understanding of the meaning in making the quotation, which doubtless suffered from not being connected with the context. No one who has studied the propeller question now doubts that the net work expended upon rearward projection of water parallel to the line of thrust is the measure of the work applied to propelling the ship; that is to say, to the overcoming of the pressure and inertia of the water and the resistance of skin friction. The anomalies originate from the fact that screws of precisely the same form, so far as can be determined by measurement, do not give the same results on differently modeled hulls; and the exact relation between the hull and the screw which will enable the latter to develop its full power as a propeller is yet unknown; hence the best screw possible for any particular vessel is often found only by repeated trials.

THE skidding of railway car-wheels on the rails, which in practice ultimately produces flat places on the wheels, and which is caused by the brakes holding the wheels with such force that they slide on the rails more easily than upon the surfaces of the brake shoes, is an evil for which, as all railway men will admit, a practical remedy is desirable. In a little book written by Robert Grimshaw, Ph. D., M. E.,* the author,

**A Manual of Navigation for the Lakes.* By H. C. Pearson. Cleveland, Ohio: Bissell & Scrivens. 1891.

**Tips to Inventors.* By Robert Grimshaw. New York: Practical Publishing Co. 1892.

among many other suggestions of existing wants that invite consideration from those who have inventive talent, speaks of the modern methods of braking cars as "wrong in principle and injurious in practice"; and suggests that the correct principle would be "the application of superior brake-shoes or grippers to surfaces independent of the moving body, namely, on the rails." The *Railway Master Mechanic* questioned the truth of this proposition in a rather severe criticism of the book while reviewing it; but it is well known that the method of braking proposed by Mr. Grimshaw has from time to time been suggested and approved as theoretically sound by eminent mechanics and engineers. It has not been resorted to on account of plainly obvious practical difficulties, that so far seem insurmountable. It evidently has not been a difficult task for Mr. Grimshaw to compile a list of things that would be desirable were they possible of attainment, and to call these suggestions "tips to inventors"; and even if such a list were entirely made up of seemingly impossible requirements, or impracticable wants, it might serve a useful purpose. Anything that strongly directs thought to existing mechanical imperfections works for progress. But who shall assume to decide the possibility or the impossibility of securing any material thing needed in any art or industry? Since the present generation has witnessed so many achievements that a former generation would have deemed attainable only by supernatural power, it seems foolhardy any longer to call anything impossible that is desirable, unless the requirement can be demonstrated experimentally or mathematically to conflict with nature's laws. Regarding the application of brakes to rails instead of car-wheels, the chief difficulty arises from the nature of the track itself; but when it is remembered how short is yet the history of steam railroading, and that already the possibility and practicability of substituting electric propulsion for steam in moving cars, even on long lines, are commanding the attention of progressive railway men and leading electrical engineers, who will venture to predict the permanency of the present track of jointed rails, or, in short, the persistence, of anything pertaining to railway transportation?

THE "Multiple Circuit System" of heating railway-cars was noticed in this department in our February number. That article contained a statement that some features of the system resembled so closely those of the original storage-heating apparatus invented by Mr. E. E. Gold, of New York city, as to suggest a possible infringement. The manufacturers of the Multiple Circuit System—the Consolidated Car Heating Company of Albany, N. Y.— have protested against this expression of opinion, and investigation shows that it was unfounded. It is therefore now unqualifiedly retracted. In the patent of Mr. E. E. Gold, dated May 31, 1881, in "Fig. 5," is shown a cylinder or drum with steam-pipes and return bend inserted through one end for heating brine, the latter intended as a medium for storing heat to be imparted to the interior of a car by radiation, etc. The writer of the paragraph in question, depending entirely upon memory at the time of writing, was under the impression that a claim for this arrangement was allowed to Mr. Gold. The resemblance of this arrangement to that part of the Multiple Circuit System described as a drum with corrugated copper pipes inserted through one of the heads is such that, if a patent had been issued covering it, any one using the last named arrangement would have infringed that patent. It was the recollection of "Fig. 5" in the Gold specification that suggested the possibility of an infringement. It appears, however, that at the time the application for the patent referred to was made the Patent-Office did not find that feature patentable. In the apparatus of Mr. Gold it was abandoned for another arrangement. The storage-heater system of Mr. Gold does not circulate heated water or brine through pipes in the car as does the Multiple Circuit System, in which the construction of the heating drum, in connection with the circulating pipes, is a marked departure from the original plan of Mr. Gold.

THE Garland rapid-firing machine-gun, according to a report of a test recently made, is equal to a regiment of soldiers armed with ordinary breech-loading rifles, since it can fire a thousand shots per minute with a range of 1½ miles. The report of this trial,—which was made near Logan Station on the Reading railroad on December 28 last,—as given in the Philadelphia *Ledger*, shows that the gun must be in every way a remarkable piece of mechanism. It has two barrels, either of which can be used independently of the other, both barrels being inclosed in water jackets for keeping them cool in firing. The machinery for operating the gun is so far removed from the barrels that it is free from heat; and from the description given its use appears wholly confined to supplying cartridges to the barrels, extracting them when fired, and operating the firing lever. The cartridges are stated to be .40 caliber. The pointing of the gun is effected by the manipulator of the weapon through the aid of a lever without interrupting the firing. The gun is mounted on a tripod, and the gun and tripod together weigh only 154¼ pounds. This weight can easily be carried on the back of a horse or mule for a day's march. If future use develops no yet undisclosed defect, it is evident that, in this gun, one of the most destructive instruments of warfare ever known to man has been produced.

IT may not be known to many people that American manufacturers are, and for a considerable period have been, supplying mining machinery to Africa, this machinery reaching its destination via England, whence it is reshipped to African ports. This manner of transportation has recently been broken in upon, according to the *American Machinist*, which announced in its issue of January 26 that on or about January 25 "a steamer loaded with American machinery (principally mining)" was commissioned to sail directly from this port to Africa. The paper quoted stated that its information was obtained directly from "Mellin S. Harlow, M. E., of the firm of Manion & Harlow, managers of the South African Branch of the Ingersoll Rock Drill Company." Thus, slowly but surely, America is extending her commerce to and in the remotest markets of the world.

ANOTHER scheme for increasing the effect of projectiles has been proposed by Professor S. Tolver Preston, a gentleman of note in English scientific circles. The scheme lacks nothing but practicability, and it may not prove at all impracticable if engineering skill can be induced to undertake the mechanical construction implied in the proposed method. A loaded gun is to be fired from another gun which, in turn, is to be fired from still another gun, in Prof. Preston's scheme. Each of the battery of guns discharged from the principal gun is to be provided with automatic firing mechanism so timed that the discharge shall occur as nearly as possible when the containing gun—that is also a projectile—has attained its full initial velocity; the projectile from the last gun fired will then have the sum of the velocities due to the successive discharges. Thus, when the principal gun is discharged, it projects two gun barrels, one of which is contained in the other as a projectile. Both the gun-barrels then take a velocity due to the force of the explosive in the principal gun, and then, the second gun-barrel being automatically fired, the third gun-barrel is thrown out of it at an increased velocity due to the force of the explosive in the second barrel. Lastly, the third gun-barrel loaded with ball being automatically discharged, the ball that already is moving with the third gun-barrel at a velocity equal to that of this barrel is driven forward at a still higher velocity, the increase being due to the force of the explosive that projects it from the barrel. The principle may be further illustrated by supposing a gun loaded with ball to be fired directly ahead from the cab-window of a fast locomotive. The ball would then have an initial velocity equal to that it would have acquired if the gun had been discharged from a position of rest, plus the velocity of the locomotive from which it was fired. Professor Tolver thinks that an initial velocity of 9000 feet per second could

be obtained in a projectile, and that its living force could thus be increased to about nine times that ever yet attained in any projectile of equal weight. If, therefore, any practical way can be found for carrying out the scheme, at a cost somewhat less than nine times the cost of firing ordinary projectiles, the method cannot be objected to on the score of expense; while the effectiveness and penetrating power of projectiles at such a velocity would far surpass that of any projectiles hitherto employed.

A SKATING-RINK of artificial ice is described in *Annales Industrielles*, in which a frozen surface of considerable extent is maintained by a process so entirely analogous to that which has been widely employed for a number of years for cooling breweries, abattoirs, etc., not only in this country, but to a lesser extent in Europe, that it is rather surprising to see it discussed as though it were something quite novel. The article is entitled "The North Pole at Paris." This rink is handsomely fitted up with furniture suited to such an establishment, and it has an ice skating-floor of 130 x 60 feet. The freezing is effected by compression ammonia ice-machines. The only novelty in the entire arrangement appears to be the construction by which the integrity of the ice floor is practically maintained, without undue expense for mechanical power. In other attempts at maintaining artificial skating surfaces of ice there have been some failures; but in this installment, it is said, this is done with entire success. First, there is provided a metallic water-tight bottom. Upon this is laid a bed of mixed cement and cork, and upon this bed are laid the circulating pipes, comprising a total length of somewhat more than three miles. Through these pipes is pumped a strong solution of calcium chlorid, that is made cold by the action of the ice-machine. A stratum of water having been flowed over the freezing pipes, the mass is frozen by circulating through the pipes the calcium chlorid solution having a temperature of −15° C.; and when the mass is frozen solid, it can be maintained in this condition by circulating the calcium chlorid solution at about five or six degrees below the freezing point.

AN unfortunate dispute has arisen between the Council of Administration of the World's Columbian Exposition and sundry intending New York exhibitors. A conspicuous example is furnished in the case of the Babcock & Wilcox Company. As stated in the *American Machinist*, the cause of this disagreement is as follows:

> The Council of Administration have recently awarded the space to the Stirling Boiler Co. The Babcock & Wilcox Co. claim that the space belongs to them by virtue of an agreement, by which all additional power was to be supplied by the six boiler companies which made the original contract, the allotment to be decided among the companies themselves. The Council of Administration denies that any such agreement was made, and claims the privilege of allotting the space to whomever it may choose. To fortify their position, the Babcock & Wilcox Co. have obtained a temporary injunction, restraining the Stirling people from using the space. This injunction is now being contested. The Stirling Company have a large amount of material already on the ground, awaiting the decision of the court.

THE first band-saw ever invented is said by *The Engineer* (London) to have been patented in England in 1808, by Mr. William Newberry. Few would have believed that this invention, which in improved forms has become so widely used during the past thirty years, is really in its primitive form nearly a century old.

AN interesting exhibit at the World's Columbian Exposition will be the immense traveling crane, which, designed by Mr. W. H. Morgan, and driven by Thomson-Houston electric motors, will be supplied by the Morgan Engineering Company, of Alliance, Ohio, for Machinery Hall. With a lifting power of thirty tons and traversing the entire length of the hall,—1300 feet,—this splendid machine will be one of the most conspicuous things in the whole collection.

THE sharp, explosive sound of the exhaust of some types of gas-engines has

been an objection to their use in buildings occupied for offices and those used as dwellings, or places of public assembly. To obviate this objection M. P. Simon has invented a device described in *L'Electricien*. A pipe split by a saw for a distance of a little over 6½ feet (two meters) has the two branches thus formed spread apart gradually from the bottom of the split, the spreading at the end equalling the diameter of the pipe. This pipe, being placed over the exhaust, compels it to take a fan-like form, and prolongs the discharge sufficiently to deaden the explosive character to a remarkable degree. In this way the annoyance is greatly mitigated, according to the paper named.

As to the amount of power lost in engines through friction under load there is a widespread tendency to underestimate it. Even engineers of long experience are wont to believe that in engines of improved modern types the old allowances for friction under load have become much too large. Not long ago the writer asked a gentleman who ranks as an engineer of considerable attainments to state what, in his opinion, was the modern average, and he named 12 per cent. of the indicated horse-power.

When men like Mr. Alfred Saxon, as he himself confesses in a paper read before the Manchester (England) Association of Engineers, have been led to overrate the progress that has been made toward reduction of passive resistances in steam motors, men of less note may well be pardoned for falling into similar error. The gentleman named has been doing excellent work in correcting false impressions upon this subject. In the paper spoken of Mr. Saxon has given the results of comparisons made between the power given off by steam-engines in driving cotton-mill machinery, as applied to the actual performance of the useful work, and the overcoming of all the passive resistances of the machinery impelled, the difference between this total and the indicated horse-power of the engines thus investigated being taken respectively as the measure of work expended by them in overcoming their own passive resistances. The results will astonish many who have held extreme views upon the gains we have been making in engine economy. Of ten examples of spur-gearing engines, the friction under load was found to average 25 964 per cent. (say 26 per cent.) of their indicated horse-power. Of eight examples of rope driving engines the average of friction under load proved to be 29.6 per cent., a result quite contrary to the view held by many that rope driving is a specially economical method of transmitting mechanical power. Of belt driving engines, two examined by Mr. Saxon gave an average of 27.6 per cent. of their indicated horse-power. Direct coupled engines gave the best results, but of two of these the average of two examined was 23.835 per cent. Notwithstanding this average is lower than that of any of the other types of engines named, two of the spur-gearing engines compared gave results, one about the same as the best of the direct-coupled engines, and another much lower. The best one of the direct-coupled engines was found to absorb by its own passive resistances 19.67 per cent. and the second 28 per cent. of the indicated power; whereas, of the two spur-gearing engines that gave best results, one gave 18.17 per cent. and the other 19.7 per cent. The inferences and conclusions arrived at by Mr. Saxon are, to quote the closing sentences of his able paper, as follows:

> That spur-gearing engines give best results when not complicated with rope driving. [Some of the frictional data were derived from engines thus complicated.] That rope-driving engines show the best results at high rope-speeds, and that direct driving from the main drum is very desirable. That belt-driving engines for developing large powers are only equal to the average rope-driving engine with fewer advantages in other respects; and finally, that the direct-acting type of engines is likely to be very efficient.

ARCHITECTURE.

Conducted by Barr Ferree.

THE record of building operations in New York city, prepared by the *Record and Guide*,—comprising the most complete tables of their kind published,—shows a slight increase over 1891, though neither year approaches the great total of 1890, when the estimated cost of new buildings in the metropolis was $74,676,373. In 1891 the total figures were $56,072,624, and in 1892 they were $59,107,618. The number of permits granted for buildings was 2967 in 1892 and 2821 in 1891. While New York real-estate men look upon these figures as indicative of a quiet normal year, they are of the greatest interest and importance to Chicago. That city is so eagerly contesting with New York for recognition as the metropolis that such figures as these, considerably below Chicago's for the same items, may be looked upon as deciding the matter. The Chicago *Economist* places the nominal value of buildings for which permits were issued in that city during the past year at $63,463,400. Though several millions more than New York is able to show, this sum is not sufficient for Chicago. A little matter of some sixteen millions is tacked on to the "nominal" value as representing the "probable actual" value, making the astonishing total of $79,329,250. This, it is interesting to note, is far in advance of any valuation of new buildings reported by any American city, being nearly five millions in excess of the largest total ever reported in New York. Unfortunately we have seen no detailed figures of Chicago's record which would permit a direct comparison with building in New York, and enable a distinction to be made between buildings for the World's Columbian Exposition, or called into existence by it, and buildings erected through normal growth of the city. Perhaps even if such detailed statements were at hand, comparison would not be practicable. At any event Chicago's totals for 1894 and 1895, when the excitement of the Fair has passed away, will be much more interesting. A jump from $31,331,875 in 1889 to $79,329,250 in 1892 is prodigious, and, full of energy as Chicago is, there must be an after-slump of formidable proportions. Speaking of real-estate and building matters, would it not be a good idea if one of our real-estate papers would present reports from all the principal cities, at least once a year? A national real-estate journal is out of the question, local interests being too diffuse to be treated adequately in any weekly paper published in one city. Apart from showing what is being done in building, such an annual record should be of much interest to investors.

VERY little important new work was projected in New York during the past year. If cost is the standard of measurement of the importance of a piece of architecture,—which of course it would not be in any time less commercial and less bent on money-making than ours,—only eighteen buildings were begun which may be so ranked, taking $300,000 as the minimum. Small as this number is, it includes some buildings which are not architecture at all, in the usual acceptance of the word. An abattoir, a fourteen-story factory, and one or two similar structures, may be omitted from the list of additions to New York's important buildings. But we have four new large office buildings, two theaters, one large flat, one hotel, and one cable-road power-house,—that for the Broadway road,—which is strictly speaking an office building. In addition we have the new Metropolitan Club building and the new *Herald* building, the latter being destined for the exclusive use of the paper. The record is not large, among costly buildings like these, but the structures exceeding $100,-

000 in cost make a goodly list. In new office buildings the supply is well ahead of the demand, a circumstance that seems to be characteristic of all large cities. In Chicago the supply is far ahead of the demand, as might have been expected from the unusual number of very large office buildings placed upon the market in the spring of last year. Work will be begun on several new ones in New York this year, so there is likely to be no undue stringency in the office market very soon. Unfortunately for the owners of these palatial structures, the general public cannot be forced into them. If the conveniences and advantages are abundant, the rents are correspondingly high. But then the average American will tell you that, if he or his fellows want a thing, they don't care for the price. The great problem before owners of office buildings would seem to be, therefore, not to supply offices, but to create wants for them.

THE *Builder* (London) has been celebrating its fiftieth anniversary, which is a quite unprecedented feat in architectural journalism. It well deserves the great success this long-continued existence implies, for it is clearly the leading architectural paper printed in the English language, if it does not lead all the architectural journals of the world. We Americans may well contemplate this splendid record with amazement, because we have nothing that we can place beside our English contemporary. We have periodicals calling themselves architectural and appealing to architects for support; but we have likewise builders and carpenters who call themselves architects. Of the two it is sometimes hard to tell which is the more remarkable or the more out of place. If there is one grade of journalism that is overdone in this country, it is surely in the way of architecture. We do not have the literary material, in the first place, that is found in England. Neither have we the artistic material. We are building endless quantities of buildings, our architects are waxing rich, and our builders and contractors retiring at early ages on more than comfortable competencies, but very much that is published in the architectural papers in the way of illustration or of so-called literary matter is not worthy of anything save the editor's waste-basket. The result is natural: architects do not expect to find valuable matter in their papers. They subscribe for them, more as a matter of course, and because they are the only journals of their class, than because they take an interest in them. If an architectural paper wishes to find out its practical value, let it institute a census of its subscribers and find out what is done with their copies. Such a searcher after knowledge would find that one of three uses is invariably made of them: the plates alone are preserved, or the plates and some selected reading matter, or the whole thing is given to one of the young men in the office. And yet the architectural papers go calmly on, trying to persuade people they are eminently useful and valuable, when most of them should be exterminated and the rest reformed from top to bottom. There are entirely too many such papers, and the necessity that their owners shall devote all their time to the advertising department—a useful, commendable, valuable department when it is not top-heavy—deprives their literary columns and illustrations of the care and thought such things should have in every well-conducted periodical. Still, there must be "money in them," or they would not continue to be published. There is no wish, in this place, to scold our professional brethren from the standpoint of an early and pronounced success; but, dear fellows, why don't you get together, cease this continual threshing of the same ground, stop some of your individual utterances, and unite in producing two or three really good architectural papers? The material is in you if you would only go about your business in an orderly manner.

ITS fiftieth anniversary is made the occasion of an interesting summary of English architecture during the past half-century by *The Builder*. Such retrospections are extremely valuable if made with care and at due intervals, if only to show us what to avoid. And truly the architecture of

this period, in England, as well as with us, is scarcely more than the history of a succession of attempts at utilizing new styles, giving them a short trial, and then casting them aside for something new. There is nothing more monotonous or more wearing than an old-fashioned building, and every day we are seeing more and more of them. It is not necessary to go back fifty years to find structures one is utterly tired of, that are totally out of touch with current life. We all experience this, or at least we all ought to. More than anything else, it shows the utter want of basis in all modern work, save of course our own, which is too new and fresh to induce these sensations. When we travel back to the sixteenth, fifteenth, fourteenth, and earlier centuries, the first thing that impresses us is the permanency of the work. We never tire of it, and it is always fresh and suggestive, no matter how often it may have been seen. Does any living man imagine that the Western Union building in New York, the State House at Boston, the Department of State at Washington, the structure built by the Pennsylvania Company for Insurance on Lives and Granting Annuities in Philadelphia, or the City Hall of the same town, will ever have this valuable quality in the eyes of posterity? Of course we don't know what posterity will be like, and perhaps it is well we don't but if they are as great an improvement on us as we are—ahem!—on the people to whom we stand in the relationship of posterity, we will wish, could we hear their comments, that we had done anything else than try our hands at architecture. About the time posterity gets well on deck there will be a great tearing down and rebuilding, unless we look out. But let us back to our fundamental proposition: the lack of wearing quality is a cardinal fault in current architecture.

THERE are as many causes as there are samples and varieties of modern architecture. No one general rule can be laid down, because sometimes circumstances and conditions differ, and one will sometimes be more effective than another. But surely a cause that must be admitted on all hands is the lack of originality. Every architect thinks himself original, and sometimes he is quite right, too. But then, when he wants to be especially original, he sits down—and copies what other people have done. He will make a tracing of a façade, perhaps, or carefully copy the most minute detail, tack on his own outline, and send it out as something new. Here he is generally right, but then new things are not always good, nor are they always to be admired. In other words, he takes old forms, put them into new combinations, or doctors perfect things—to make them imperfect. The trouble with all the modern revivals of past architecture has been that they were reproductions of forms, not of ideas. Instead of looking at old buildings as expressing some thought, having a settled purpose, being ideas, modern architects, knowing these properties could generally be depended on to be absent from their own productions, imagined they must be absent from buildings erected in all ages. And so, admitting that the modern building is wholly modern, old forms have been plastered on to it, pushed, shoved, dragged onto it until almost unrecognizable. It did not matter whether they belonged where they were put, or whether they performed any useful function. Admired in one case, they were supposed to be admirable in all. This is certainly one great cause, if not the chief one, of the lack of permanency in modern work. Styles in buildings have changed in the last half-century, almost as often and certainly as rapidly as styles in dress. There has been too much time wasted in giving short trials, and that without starting at the beginning and commencing with the idea. The buildings going up now seem modern, but that is because they are new. It is too soon yet to determine their permanency. Many structures built only twenty-five years ago, or even more recently, would be impossible in the present day. An old building fades as rapidly as an old dress. Our architecture is an architecture of forms; an architecture of spirit, of thought, of idea, has yet to be evolved among us.

AN article in the current number of the

Quarterly Review proposes a remedy for the diseased condition of modern architecture in the banishment of the architect, draftsman, and all who build buildings with T-squares and compasses, and the substitution of the workingman, filled with a genuine ardor for his task, and who would design as he builds, or build as he designs. This is an attempt at the rehabilitation of the medieval workman, of whom we hear so much and know so little. But we need not bother ourselves with him; we have the modern variety, and know pretty much what he can accomplish and what he would do if all architecture and building were put into his hands without the restraining check of a guide. Of course the first thing would be a strike. He might not know what he was striking against, he might have no grievance, real or imagined, but things would be very bad indeed if he could not treat himself to a strike, especially as an appropriate celebration of his independence. There is no doubt at all but that architectural workmen might be improved by undergoing a serious study of their work, but a few years ago this very experiment the *Quarterly* pleads for was tried in England, and much was expected from the capitals and ornaments carved and designed by the workmen "out of their heads." The results then did not justify any continuance of this line of experimentation, and there is no reason to suppose a trial at this day would produce better results. It is a most mistaken notion to imagine that all that is good in medieval work is the spontaneous work of untrained laborers, just as it is a mistake to suppose buildings were erected in the middle ages without regular plans and careful study. But whatever the workman did then, he was a very different species from his present representative. Every artistic workman has as good a chance to distinguish himself to-day as in the most artistic period of the thirteenth century. Architects and employers are constantly on the look-out for such men, and they have every opportunity to produce good and real work. If there are but few, it is because the material is limited. The workman of this day and generation is too busy getting his wages, and negotiating strikes, and paying assessments, to care for art. And after all, architects cannot expect to avoid the penalty of their own misdeeds by putting them on to the workman. He may need reformation, but the architect had best look after his own sins, rather than after those who naturally look to him for leadership.

WE are very glad to give space to this communication from Professor William H. Goodyear, whose papers on "The Influence of Greek Architecture in the United States" were criticised in this department last month:

Regarding the comments on my articles written for *The Chautauquan* on "The Influence of Greek architecture in the United States," I wish to make the following reply. The review suggests that I have included Renaissance illustrations under the class of buildings showing Greek influence. This is not the case. In two of my articles each illustration of Renaissance or Roman-Greek revival is so specified, even in its title. In all three papers I have been careful to explain the distinctions between the Greek revival and the Renaissance and to call attention to the illustrations which show this distinction, and the entire argument is bent to show that the former was a reaction against the latter. I have also quite explicitly stated the facts regarding the amalgamations of forms of the Greek revival with forms of the Renaissance, and the illustrations which show this amalgamation are stated in the text to have been used for this purpose [see my second paper]. I must differ with the view that Girard College is not a building of the Greek revival because it is Corinthian. The capitals of Girard College are copies from the Choragic Monument of Lysicrates. Copies of the Greek peripteral form like Girard College are absolutely unknown to the Renaissance. Your advice that the upper portion of St. George's Hall in Philadelphia is a subsequent addition does not relieve the building from criticism in its present condition as illustrated. Moreover, if you will examine the building, or my picture, you will see that the original construction breaks away in plan at the point where the pediment is introduced. The criticism on my sentence regarding modern imitations of Greek buildings is a misapprehension of its meaning. What I have said is that some buildings are copies from the Greek and others are copies from the copies.

WM. H. GOODYEAR.

IT would be interesting to know what proportion of our busy architects read that bright paper, *Fire and Water*. It is to be hoped that a large number of them do so, if for no other reason than to have seen the series of articles on the "Blunders of Fireproofing," recently published in it. The author, Mr. T. R. Tinsley, is an ex-Inspector of Public Buildings in Kansas City, Mo., and he has drawn to his support the help of the Fire Chiefs of many of the Western cities. It is the testimony of these gentlemen which would chiefly interest architects, and the opinions of men who look at construction from a totally different standpoint than does the builder cannot help but be valuable. The object of the articles seems to be a demonstration of the inefficiency of modern fireproofing in general and of slow burning construction in particular. A number of instances are cited by the contributing Fire Chiefs of disastrous fires in buildings erected on this principle, though it is admitted on all hands that, as a rule, slow-burning construction will burn slower, and the structure stand longer, than one not so built. More is not claimed by the strongest advocate of the system. But then the firemen find a fresh danger in this, since, if the building burns slower, it burns steadier and with an intense heat that is often more dangerous than a rapid fire. Criticism such as this is entitled to the most careful consideration, but neither the slow burning principle nor the effort of modern architects to reduce the dangers from fires by the use of non-combustible material is to be slightly set to one side. The readers of the interesting paper by Mr. Bebb on the fire in the Chicago Athletic Club building, in the last number of this Magazine, have a much better conception of the present status of fireproofing than those who have looked at the subject through the spectacles of the fireman. The latter should by no means be overlooked, but it is impossible to follow an author who evidently expects architects to devise a structure that will resist and concentrate a fire within itself. A fireproof structure filled with inflammable material must be dangerous, and all the skill of the architect cannot make it otherwise. Certainly it should not be a requirement of a building that it should be an oven of baked clay, capable of withstanding all manner of heat. If this be the fireman's ideal, he needs some little study in modern architecture.

RECENTLY we had occasion to refer to the movement towards a uniform insurance standard which has been agitated in insurance circles for some time past. Architecturally this is of the first importance, as are all matters relating to fire insurance, though it would be an interesting question to determine what proportion of architects read insurance papers, or the insurance columns of the daily press. A final Universal Mercantile Schedule has just been printed, embodying the results of the committees having the matter in charge. In this connection the following excerpt, kindly furnished us by Mr. J. M. Bancroft, will be of interest:

"A universal rating schedule for insurance rates has recently been adopted by representatives of the leading insurance companies, its object being to secure equitable rating by classing risks of the same character alike, wherever situated. It has necessitated a thorough inspection of each risk, and will tend to secure reforms in fire-departments by making proper charges for faults, disbanding of force, failure of water works, defective hose, etc. It will encourage more care on the part of the assured by making deductions for general cleanliness and care, such as the use of fire pails, keeping clean and clear of boxes and rubbish, and having ashes properly cared for. Lastly, the schedule encourages proper construction of buildings by intelligently charging for deficiencies, and recognizes good construction by deductions. The builder and property owner can be informed at the outset what can be saved by proper construction, and be led to avoid many of the faults now prevailing; new buildings would be constructed according to correct methods and thus lessen the danger of sweeping conflagrations in cities, since a single building may prove a barrier which will enable a fire department to control a fire, as was the case in Boston in 1889."

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

THE production of pure naphthalene, which of late is being much used in the manufacture of a line of dyes parallel to the anilin, is described in the London *Industries*. A drawing of the plant, unfortunately, is necessary to a perfect understanding of the method, but we will give in brief outline the main steps involved. Five tons of impure naphthalene obtained from the fractional distillation of coal-tar is placed in a still, together with thirty pounds of 70 per cent. caustic soda of 70° Twaddle. The still is 7 feet in diameter and 7 feet deep. The first products of distillation, the temperature being raised to 210° C., are water vapor and oily matter. The heat is then raised to 235° C., and the distillation of the naphthalene is begun. The vapors passing through a water-cooled coil are condensed as a hot liquid in a proper receiving tank, where in the second step of the process this liquid is thickened to a mortar-like consistency by the addition of naphthalene residues from previous distillations. The mass is now placed in bags and subjected to a pressure of three tons per square inch, the oily matters are expressed, and the naphthalene left as a hard, sonorous cake. The "pressed material" is now charged in a second still with about a hundredweight of best thirds commercial sulfur and distilled, the first runnings being separated and afterwards used in working up succeeding tankfuls of naphthalene. The liquid naphthalene produced is kept for twelve to twenty-four hours and is then forced by air pressure to a third still, where it is mixed with 50 pounds of 70 per cent. of caustic soda, 70° Twaddle, and distilled as before. The finished naphthalene is run off into galvanized iron cases of 100 pounds capacity and allowed to solidify, after which the blocks are broken into small pieces. This final product is of high, purity, melting at 79.+279.5° C, and is entirely free from all oily matter.

AN interesting review of the glass industry for the year 1892 by Mr. R. M. Atwater appeared in a recent number of the *American Manufacturer*, from which we abstract the following:

The past year cannot be set down as a successful one, though it has been one of great activity. The cause of the demoralized market and the low and fluctuating prices may be found in the two factors of high protective tariff and natural gas, neither of which ordinarily is looked upon in the light of an evil. The glass-makers of the country have, however, been led to rely upon an artificial basis,—that is, the tariff,—instead of on the only safe basis, the open market. Methods have not been improved materially under twenty years of protection, while the foreign makers have practically made their business entirely over and are to-day, with poorer material and higher-priced fuel, making better glass than we at about half the cost.

Another weakness of the American manufacturer is the small capital necessary to start a plant. As long as the largest manufacturers are contented to continue in the old-fashioned, cheap, direct-fired furnaces, which have not been essentially improved since the days of the Pharaohs, they are an easy prey to any adventurer who can rake together a few hundred dollars, run a brief career while the market is good, and sell out to some one else in time to save himself when prices fall. Abroad, the improved methods, requiring expensive plants and large capitalization, have reduced the cost of production and at the same time have prevented this injurious mushroom growth.

The tariff and natural gas combined have made the glass business a field for gamblers in gas-fields, "boom" towns, and merchandise. Every speculator in gas-fields has invited glass-factories to help push his boom. The market was flooded with

job-lots of ware from localities that but a few weeks before had never seen a bottle blown. The demoralizing days of the "fifties" in California were equalled in the rush to these lands of promise. No better indication of this condition need be cited than the enormous number of fires in glass-houses in 1892. They reached over fifty in number, and over $1,000,000 in the value of property destroyed. We do not intend to imply that these fires were deliberate sales to the insurance companies, but they indicate the recklessness which is now a strong characteristic of the business.

Mr. Atwater finds in the recent union of the stronger companies into a syndicated consolidation a bright promise for the future,—a promise for better methods both in process and management, and a check upon the deleterious mushroom growth spoken of above. He predicts for the years 1893, 1894, and 1895, a steady lessening in the number of glass factories, but an increase in the capitalization of those that remain, and steadily improved markets and profits. Early in February the window-glass manufacturers and jobbers allied themselves together in a combination to be known as the National Glass Company. This was incorporated under the laws of Wisconsin with a capital of $200,000, New York, Pennsylvania, Indiana, Ohio, Illinois, and Michigan being represented. The reason given for the establishment is that regular prices may be maintained. However this may be, a schedule is to be prepared by the directors which will be enforced under a penalty of the forfeiture of a large sum of money which each manufacturer will be required to deposit.

It happens that Mr. Atwater is a contributor this month to the pages of THE ENGINEERING MAGAZINE, furnishing a paper full of interest on the progress of the glass-making industry in America.

THE *American Gas-Light Journal* recently contained an article from the pen of Mr. G. Minchin on the subject of photo-electric-cells. The preparation of these delicate little instruments may be of interest, and will be described briefly here, as is done by Mr. Minchin.

The cells which are employed for obtaining electro-motive force from the light of the stars and planets are known as seleno-aluminum cells. They are constructed in the following way: Take a small flat strip of aluminum about ¼ inch long and 1-16 inch broad; let this be heated on a clean iron plate placed over a Bunsen flame, and while it is hot let a very small bubble of melted selenium be rapidly and uniformly spread by means of a hot glass rod over about one-third of the length of the aluminum strip, the selenium forming a very thin layer. The strip is now removed from the iron plate, which is partially cooled, and then again replaced and heated slowly. This process of gradual heating is repeated until the surface of the selenium layer has become changed from black to gray in appearance, in which latter state it is sensitive to light. When this is accomplished, the strip is joined with good electrical contact to a very fine platinum wire. The cell into which the now finished sensitive plate "is to be inserted is a very fine glass tube about 1½ inches long, into which a platinum wire pinched to a clean plate of platinum has been sealed; the size of the latter plate is immaterial—it may be a mere speck of the metal at the end of the platinum wire; it is the inactive plate of the cell. In the glass tube, thus closed at one end, is inserted (by means of a pipette with a capillary stem) a quantity of pure acetone sufficient to occupy about one-quarter of the length of the tube, and then the sensitive plate is inserted until its sensitive extremity is very nearly in contact with the inactive plate, the whole of the sensitized part of the plate being covered by the acetone. The platinum wire of the sensitive plate which now projects through the open end of the cell must be sealed into the tube, the end of the tube being, of course, completely closed by the sealing."

To procure constancy in the cell it is necessary to use perfectly pure acetone and selenium in its composition, and when the cell is not in use to invert it, thus drawing the liquid away from the plates. The electro-motive force produced by the action of ordinary diffused daylight is equal to about

0.5 volt, while the light from a candle at a distance of seven feet is said to produce 1.30 volt. The yellow rays of the spectrum give the maximum of force, though light of all refrangibilities is effective. As naturally suggests itself, the voltage may be multiplied by connecting up several cells in series.

A SERIES of four interesting Cantor lectures, delivered by Mr. Vivian B. Lewis before the English Society of Arts, have recently been published. His announced subject is the "Generation of Light from Coal-Gas," but the matter of his first lecture deals most entertainingly with the whole subject of combustion in the production of light, following in chronological order the various opinions that have been held from the days of William Murdock, the first "gas-man," to the present day. It was in 1792 that William Murdock lighted his house and office with gas generated from coal by means of a primitive retort in his back-yard. Five years later, through the reading of Lavoisier's "Chemistry," Sir Humphry Davy began his life of scientific research in this same county of Cornwall. Rapid indeed were the strides of this genius in science, and 1802 found him a professor at the Royal Institution. It is not our purpose, however, to review here the life of this man, or even to follow Mr. Lewis in the interesting account of Davy's experiments with flame combustion. His results, however, we will give in his own words:

"I have given an account of some new results on flame which show that the intensity of the light of flames depends principally upon the production and ignition of solid matter in combustion, and that the heat and light in this process are in a great measure independent phenomena."

In a previous paper, after first elucidating this same newly-discovered principle, he says:

"This principle of the increase of the brilliancy and density of the flame by the production and ignition of solid matter appears to admit of many applications. First. It explains readily the appearance of the different parts of the flames of burning bodies and of flame urged by the blow-pipe: the point of the inner blue flame where the heat is the greatest is the point where the whole of the charcoal is burnt in its gaseous combinations without previous deposition. Second. It explains the intensity of the light of those *flames* in which *fixed* solid matter is produced in combustion. Third. It offers the means of increasing the light of certain burning substances by placing in their flames even combustible substances."

Mr. Vivian now proceeds with a summing up of Sir Humphry Davy's theory, followed by a few remarks on the limited work of the next thirty-five years, speaking of the theories of Berzelius, Kersten, and Graham-Otto. The second lecture begins with a short sketch of the work of Dr. Edward Frankland, extremely laudatory in character. Dr. Frankland's investigation as to the effect of diminished or increased pressure upon a flame is most interesting. He found that the rate of combustion was but little affected, but that "of 100 units of light emitted by a gas flame burning in air at a pressure of 30 inches of mercury 5.1 units are extinguished by each diminution of one inch of atmospheric pressure, or, more generally, the diminution in illuminating power is directly proportional to the diminution in atmospheric pressure."

At the time of those experiments, 1861, Dr. Frankland held Davy's theory of flame-combustion, but later, in 1868, he communicated a paper to the Royal Society in which he questions this same theory, finding "many flames possessing a high degree of luminosity which cannot possibly contain solid particles." He gives in substance the flame of burning hydrogen or carbon monoxid in oxygen which under sufficiently high pressure becomes luminous. "For these reasons I consider that incandescent particles of carbon are not the source of light in gas and candle flame, but that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapors."

This paper by Dr. Frankland naturally caused a sensation, and many defenders of the old belief appeared, one of the first

being Mr. W. Stein. Dr. Karl Heumann also criticises Frankland's hypothesis, pointing out that, while his experiments are valuable, they are not conclusive and do not warrant us in relinquishing the theory of Davy. He is supported by Soret, who in 1875 proved the existence of solid particles in a luminous hydrocarbon flame. Buck and Sir George Stokes have also lately succeeded in experiments of like nature. Thus, Dr. Frankland's theory, though it has shown that solid matter is not a necessity in all luminous flames, is still denied to be the proper explanation of the class of flames under consideration.

Professor Smithell has described the development of a luminous hydrocarbon flame as follows: "The hydrocarbon issues from the burner or wick—let us suppose—as a cylinder column. This column is not sharply marked off from the air, but is so penetrated by the latter that we must suppose a gradual transition from the pure hydrocarbon in the center of the column to the pure air on the outside. Let us take a thin transparent slice of the flame near the lower part of the wick, or close to the burner. At what lateral distance from the center will the combustion begin? Clearly where enough oxygen has penetrated the column to give such partial combustion as takes place in the inside of the Bunsen burner. This then defines the blue region. Outside this the combustion of the carbon monoxid, hydrogen, and any hydrocarbons which pass from the blue region, takes place, and constitutes the faintly luminous region. These two layers form a sheath of active combustion surrounding and intensely heating the hydrocarbons in the central part of the column. These heated hydrocarbons rise and are heated to higher temperatures as they ascend. They are accordingly decomposed with the separation of carbon in the higher parts of the flame, giving us the yellow region; but there remains a central core in which neither is there any oxygen for combustion nor sufficiently high temperature for decomposition." Professor Smithell then proceeds to describe the conical flame, applying these same principles.

MR. LEWIS, to continue in the same connection, has investigated carefully the composition of the flame at its different points with a view of ascertaining how the carbon becomes separated in the yellow luminous region. The per centage of total unsaturated hydrocarbons and the percentage of acetylene were determined in each of the flame zones. The gas in the burner yielded 0.035% acetylene, at one half inch above the rim there was 0.340% present, and at the tip of the inner non-luminous zone the acetylene reached 1.410%, or over 70% of the unsaturated hydrocarbons present. The small proportion remaining and the acetylene penetrate into the luminous zone, where they are both decomposed. The tip of the luminous zone yielded neither unsaturated hydrocarbons nor acetylene. In the decomposition carbon is liberated, and, being for a moment heated to incandescence, gives luminosity to the flame.

In order to cause luminosity a temperature must be reached sufficient to dissociate the acetylene; otherwise, in the presence of oxygen, the latter burns with a non-luminous flame. If the temperature necessary is obtained, the liberated carbon becomes incandescent, chiefly from its over-combustion, though aided by the combustion of the hydrogen liberated at the same time. The greater the dilution of the acetylene the higher the temperature needed for its dissociation; consequently with gases yielding small percentages of acetylene a higher temperature is found at the commencement of the luminous zone than in those flames yielding more of this hydrocarbon. The following neat little experiment for illustrating the effect of cooling on luminous flames is due to Heumann. If a small luminous flame be allowed to play upon a platinum dish, so much heat is extracted for the moment that the temperature falls below that necessary for the decomposition of the acetylene, and the result is a non-luminous flame, becoming luminous again, however, upon the final heating to redness of the platinum. To demonstrate whether the illumination was actually due to the incandescence of the carbon, or in other words whether the acetylene was decomposed to

carbon or, corresponding to Frankland's theory, to heavy hydrocarbons, Mr. Lewis conducted a second series of experiments proving conclusively the first supposition to be the true one. Finally we will conclude in Mr. Lewis's own words describing the results attained:

"As the gas leaves the jet, the hydrogen rapidly diffuses to the outer edge of the flame and burns, the methane doing the same but rather more slowly. The combustion of these gases raises the temperature 500° C. in the first ½ inch, whilst before another ½ inch has been traversed 1000° C. is reached and the chemical changes in the hydrocarbons are progressing rapidly, the unsaturated hydrocarbons and higher members of the saturated hydrocarbons being rapidly converted to acetylene. If the temperature of the flame were not allowed to rise above 1000 C., this acetylene would be nearly all polymerized into benzine, naphthalene, diphenyle, and other complex bodies, which would be slowly burnt up without liberation of carbon, and a non-luminous flame would result. In the case of a gas flame, however, instead of remaining at 1000° C., the temperature rapidly rises to 1200° C., with the result that, instead of polymerizing into more complex bodies, most of the acetylene formed at once splits up into carbon and hydroge, and the former, heated to incandescence by combustion, gives the luminosity. It is the attainment of this temperature which marks the limit of the non-luminous zone. If this were the only action, however, the luminous zone would be very short. The bodies, however, formed from the acetylene before 1200° was reached, and the methane, of which some still remains unburnt, are converted into acetylene at a still higher temperature, *i. e.*, 1300 C., and this, being reached near the top of the luminous zone, yields a fresh supply of carbon and so increases the height of the light-yielding portion of the flame."

In our opinion a more masterly explanation of flame combustion has never been presented than this just given by Mr. Vivian B. Lewis.

LAST month THE ENGINEERING MAGAZINE noted the figures of Messrs. Cross and Bevan regarding the production of caustic soda and bleach by electrolysis, and spoke of the vast field being opened in this department of combined chemistry and electricity. A brief review may now be given of one of the successful applications of the recent discoveries referred to, namely, the production of an electrolytic disinfectant and purifier according to the method of Eugene Hermite. This process was employed with good success during the recent cholera visitation at Havre and Rouen, and consists essentially of the electrolysis of solutions of salt, sodium chlorid, or any of the chlorids producing a decolorizing and disinfectant solution of high efficiency. The plant required is simple and inexpensive. On the ground floor of a two-storied building are placed the boilers and engine, while the dynamo and the tank in which the electrolysis takes place are situated on the floor above. It would seem more advantageous, however, to place the dynamo below, reserving the second floor for the electrolytic bath alone. Sea-water or the prepared solutions of the chlorid is pumped to the tank and there electrolyzed with the production of hypochlorites and other compounds of chlorin of disinfecting and antiseptic value. The solution is drawn by gravity directly from the tanks to reservoir carts for distribution. But it is not only as a means of extraordinary disinfection that this process is valuable; it is aimed to procure through it a successful solution of the sewage problem. The journal *Electricité*, from which this review is largely adapted, speaks of the present inadequate and dangerous method used in Paris for the disposal of the sewage, which is now partly employed in irrigation at Gennevilliers and Achères on the Seine. Some hundred of acres are there being created into hot-beds of disease germs from all the city of Paris.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

THE proposal of some members of the New York Senate to fix a maximum price for coal throughout the State by legislative enactment is a fresh example of the incompetency of the average politician to deal with economic problems. Very likely these Solons are sincere and well-meaning; possibly the move is only a piece of demagogy. Let them have the benefit of the doubt. At all events it is evident that the number of people is growing who think that everything can be done by act of Congress or by act of legislatures or by municipal ordinance. A bad sign when the Kansas idea finds supporters in a State like New York. It might have stopped short with the overwise Chancellor of New Jersey.

This is no place to discuss the ethics of the matter. Admit that it is within the province and function of government to meddle with private business and go to the silliest extreme of socialism or paternalism. Admit that it is proper for legislation to fix the hours and wages of labor, the price of bread or of anything else—if it can. It is sufficient to note that artificial laws which antagonize the natural and absolute law of supply and demand inevitably fail in their purpose and defeat themselves. They may do harm, but they do no good. Suppose a legal price for coal to be such that there is loss or no profit in mining and handling it. Then the supply will be cut off, for no enactment can compel miners to mine or dealers to sell coal for sweet charity's sake. Suppose the legal price to be higher than the normal one. Then it will be disregarded, dealers will undersell, and the law becomes an absurdity. Or, suppose it be attempted to establish a sliding scale which will allow a fair but moderate profit to operators and follow the natural course of the market in its ever-shifting phases. The mere statement of the supposition provokes a smile.

No doubt coal combines do artificially raise prices temporarily. In the long run the effects are about equalized, and the average scale adjusts itself to natural conditions, showing that the coal companies are hardly more successful in wrestling with economic law than are the legislators; though the former have it in their power to regulate production to a certain extent, while the latter can only indirectly prohibit it by stopping sales. When lawmakers stand in the track of the industrial machine, one is reminded of the old story of the bull and the locomotive. You admire the nerve, but doubt the discretion.

IN his report upon the Harney Peak (South Dakota) tin mines, Captain Josiah Thomas says:

> I have not attempted in this report to advance any theory as to the origin or formation of the various deposits, nor to give any opinion as to whether some of them are true fissure veins or otherwise; for, after all, these points are mere matters of opinion, and not of much practical importance.

Such a statement standing by itself would probably misrepresent its author's meaning, for Captain Thomas, the superintendent of the famous Dolcoath tin-mine in Cornwall, is an accomplished miner and is recognized as perhaps the foremost authority in this kind of mining. He would hardly make such a broad assertion unqualified: and the qualification is given in this very report by his laying stress upon the geological conditions affecting some of the more important locations examined. He evidently means in the quotation just cited to explain that a technical description of all the unpromising claims included in the Harney Peak properties would not be worth while. Taking the bare statement, however, it may serve as a text for a short sermon on one much-vexed question: What practical difference

does it make whether a deposit (of tin or of almost any other metalliferous ore except iron, manganese, and a few peculiar copper deposits) is a "true fissure vein" or something else? American miners of gold and silver used to entirely overrate this one type of ore deposit, deriving their opinion from their experience with the California gold veins and the first discovered silver-mines of this country, nearly all of which had a similar mode of occurrence,—that is, were more or less regular veins. In the "sixties" and early "seventies" this term "true fissure" had become a sort of shibboleth; any mines to which it could be rightly applied were supposed to have extraordinary advantages, and hence it was often misapplied for the sake of the assumed commendation. Consequently "blanket lodes" (beds), "contact veins," etc., were by inference disparaging names. But after the opening of some of the great silver-lead deposits in limestone the older notions had to be reconstructed, and prejudice swerved almost to the other extreme for a while. At present the prevailing sentiment may be summed up about as follows: Whether a deposit is of the "true-fissure" class or not has nothing to do with the size or richness of its ore body or bodies. As fissure veins usually dip at a steeper angle than 45°, they require as a rule deeper (and therefore more expensive) mining than the generality of bedded deposits, which commonly have a flatter dip than 45° from the horizontal, and which, if mined, are generally not far from the surface. On the other hand, fissure veins are likely to have certain characteristics that are of perhaps more than equalizing weight. They are more easily traced by their outcrops, if they have any; they are more regular and persistent in length and depth, which means that they can be explored systematically with a reasonable expectation of finding them in new positions underground according to calculations based upon measurements of direction in the developed portions. They may be thrown out of place by faults, but so are other kinds of ore deposits, though possibly to a less extent; but their typical form is that of a tolerably regular plane. While the workable ore in such veins is sometimes confined to certain favored spots or chutes, still as a general thing it is more evenly distributed than in other forms of deposits. This less degree of concentration may be a disadvantage in extracting, since more material may have to be handled to get a given value; but on the whole it is made up by the greater certainty of finding. A concentrated bonanza in an irregular formation is a nice thing to have, after it is *found;* but the plums in the pudding (plums — ore bodies; mass of pudding — limestone-porphyry contacts, for instance) are likely to be scattered in such a way as to make underground prospecting more a matter of guesswork than in the other case. The form of occurrence may therefore have considerable significance. Of course all this is to be taken in a broad sense, and is by no means universally applicable. But even rough generalizations have their use,—especially when some one wants to sell you a mine on the strength of its belonging to a particular geological type. Then it is well to have some idea of what the *pros* and *cons* abstractly amount to, though, after all, ore in sight is about nine-tenths and geology about one-tenth of the case.

THE American Iron and Steel Association has returned to the use of the "gross" or "long" ton of 2240 pounds in its reports, after having quoted the "net" or "short" ton of 2000 pounds since 1865, when the latter was formally approved. The change is made in response to the wish of the majority of the members. It is to be regretted on some accounts, for the 2000-pound ton is the official unit in our census reports, is used for most other metals and ores, and certainly is more convenient in calculations. Still the gross or long ton corresponds with the English standard and also comes so close to the metric ton (of 2204 pounds) as to be roughly comparable with the continental unit without reduction. Our irrational, confused, and confusing system (or want of system) of weights and measures seems to be no nearer a finality in standards than formerly. There is less and less

prospect for the adoption of the metric system in trade here as the years go by and the change becomes more difficult. In metallurgy we have the strange anomaly of large volumes and weights being quoted in the English system or something like it, while the smaller quantities used in analytical work are frequently taken in the metric system (as is becoming the custom in chemical practice generally), thus often necessitating troublesome conversions of results from one system to the other.

WHAT especially impresses the American reader of the Queensland geological reports (and this applies to those of the other Australasian colonies also) is their very practical character. The field work is confined to matters of economic importance, the discussion of which necessarily brings in some wider questions of structural geology; but the method of treatment in the reports is so simple and free from needless technicalities that the descriptions and explanations are comprehensible by any intelligent miner, while the information conveyed is precisely of the kind to be of service to him in his work. The subjects cover various gold-fields, both alluvial and lode deposits, tin, coal, etc. One report gives advice about artesian wells and was made for the definite purpose of ascertaining the probabilities of striking an artesian water supply for the city of Brisbane and to point out the most likely places for boring. Some of the districts surveyed are old and abandoned, having been reexamined with a view to throwing light upon the question of the advisability of reopening them. Others are new ones, and the information gained by timely reconnaissance gives miners data for deciding whether it would be worth while to take up leases and undertake work there. If we had in America similarly prompt and authoritative information about new mining districts, so far as geological knowledge is any guide, it would save considerable lost motion and head off many of the senseless rushes to newly-discovered fields, besides giving the miners some basis for planning exploratory work. But here our geological reports are generally made after the fact,—that is, after the districts have been so thoroughly opened that the miners fully understand them and don't need the advice of geologists; often indeed after the period of greatest productiveness is past and the district is in its last stage of decline. Geological reports then are useful as matters of record, and by discussing problems in the science of ore deposits may perhaps apply in similar cases yet to arise, but so far as local utility is concerned they have little value. It would be too sweeping a charge to say that all American geological reports are merely matters of ancient history. Professor Winchell's report on the Mesabi iron range, previously mentioned in these pages, is an instance to the contrary; and so are some of the other State reports, and sometimes the Canadian reports. But it is too generally the truth. There is some reason for this, apart from the usual dilatoriness of officialism, in the reluctance of geologists to commit themselves by going on record in regard to districts not well developed. But that is just the time when their advice is wanted and might be of some direct use. Besides, on the part of official geologists, this is what they are supposed to be paid for doing.

Another merit of these Queensland reports is that they are accessible to the men who are interested in them. They are unpretentiously gotten up and are issued as separate pamphlets according to topics, thus clearing up the field work as it progresses, and are sold at a few pence each.

IT is estimated for a French electrometallurgical company that by using a modification of the Heroult process it will be possible to produce aluminum at a cost equivalent to less than 15 cents per pound on the basis of a yearly output of 3000 tons. It will be remembered that Mr. Alfred E. Hunt has estimated the cost of producing aluminum by the Hall process, if conducted on a large scale and using water power for generating the current, to be about 19 cents per pound. It was also estimated by M. Camille Faure that, by his process of reduction by electrolysis of

aluminum chlorid, a cost of about 20 cents per pound would cover expenses, while by the sale of the chlorid of lime by-product it was expected that the net cost of the Faure process might be brought very much lower,—even to about 3 cents per pound, according to the sanguine inventor. What the producing companies are really doing is of course a very different thing from estimated possibilities. At present prices the demand has been so increased that it can hardly be expected that quotations will fall much lower until extraordinarily large and economical works are built.

Taking a conservative view, and assuming for the immediate future a cost of say 20 or 25 cents per pound as the probable minimum, it must be admitted that the rapidity with which the production of aluminum has been cheapened has been astonishing. Only a decade back, when the price was several dollars per pound and the utilization necessarily very limited, it seemed absurdly visionary to imagine that even the present stage would be reached so soon, if ever. Only two years ago it was hailed as a great achievement when the cost was brought below $2 a pound. Now, at a cost only a quarter of that, it is seen that a considerable margin for further economies is left. Even at present prices, a sixteen-story building in Chicago is to be faced with aluminum plates instead of the usual terra-cotta or brick veneer, according to report. In the case of an industry like that of aluminum-making it is never safe to predict very far ahead. It may be that even now we are relatively in much the same position as before, when the sodium method was regarded as the only practicable one. Further surprises may be in store; as for instance the realization of what once seemed a chimerical dream rather than a chemical possibility,—a direct smelting process, without the application of electric heat. The substitution of a cruder, cheaper material as "ore" in place of the expensively prepared artificial alumina or the chlorid, so that a reasonably pure clay could replace bauxite, etc., would be an immense step, and might effect a greater saving than even the direct use of fuel in place of the electric method.

It is not believed that the metallurgy of aluminum is to come to a dead halt at a stage not much advanced beyond the present, for there is much to be done even on existing lines. But supposing such a stop, it would be well for those who are disappointed because aluminum is not yet as cheap as iron, and who may have to give up any expectation of that sort, to reflect that the real progress already made, especially in its alloys, has been beyond the hopes of practical metallurgists, if short of the enthusiastic prophecies of newspaper writers.

FROM an interesting comparison of the statistics of the German iron industry, made by the *Colliery Guardian*, it is shown that the exports, the production, and the consumption of all kinds of iron in Germany have increased enormously in the last twenty years, and that the average consumption of iron per head of the population has been much larger during the later than it was during the earlier years of this period. In Germany the *per capita* consumption of iron and steel has ranged from 35 to 81.7 tons, the latter figure being reached in 1890, while in 1891 it fell off to 66.6 tons. So far as the foreign iron trade is concerned, it is known that Germany imports mainly pig-iron, and less finished iron and steel than most other countries, while the growth of its exports of finished products is seriously alarming competing nations.

THE "lead-bath" process of extracting gold and silver from ores is being revived in a new and complicated form, in which the lead bath itself is made only the final stage of a series of operations, including the desulphurization of the pulverized ore by ignited water-gas. The idea of the lead bath is a very plausible one. It appeals to unpractical inventors of metallurgical processes with such force that it constantly recurs in one shape or another in patent specifications, but heretofore has never got much further; and it is extremely doubtful whether it ever will, since the mechan-

ical difficulties are decidedly awkward, to say nothing of the losses from volatilization, oxidation, and entrapped particles of molten lead (containing precious metal) carried off with the tailings. In this respect it has rather more serious disadvantages than those attending the equally plausible mercury bath and vaporized mercury schemes. In theory a method which brings each particle of ore into intimate contact with an absorbing fluid metal is very promising. This is what lead-smelting does for silver and gold ores so successfully, and it doubtless seems to the process inventors that to use the same lead over and over and to avoid the necessity of fusing all the gangue and adding barren fluxes must be a great achievement. Unfortunately the application of the lead-bath principle in practice presents too many drawbacks, which so far have not been overcome.

OF course it is only a question of time when in any limited natural-gas district the supply will be exhausted. For a while it may be eked out by sinking new wells, but there is sooner or later an end, as with petroleum and indeed with all other natural resources of the kind. The period of life may be longer or shorter, but it is finite. Bringing the gas from longer distances and the introduction of gas-pumping plant give but temporary relief. The great diminution in pressure in many of the older districts is causing renewed alarm and in some cases serious loss to industries dependent upon natural gas for fuel. In the Findlay (Ohio) gas-field the service by the city lines was recently discontinued to manufacturing establishments, making trouble for the glass-works, rolling-mills, etc., and other places also are suffering.

The unusually severe winter and freezing of the ground caused many explosions of natural gas, while the fear of such accidents led to the disuse of this fuel in other places, with much inconvenience to customers. A coal-trade periodical takes advantage of the situation to say that "it seems but reasonable to advise that this deadly and insidious fuel be left in the pockets which nature has provided for it and thus avoid all possibility of danger, especially when a better and more abundant fuel can be found in coal." This is going rather far. Why should not the natural-gas people retaliate by emphasizing the dangers of coal-mining?

WRITING to the *Engineering and Mining Journal*, in answer to a correspondent who complains at having been to the expense of an expert examination of a mining property which proved to be worthless, another correspondent very sensibly says:

> Require the vendors to deposit sufficient money to pay for a professional investigation of their proposition, which, if the scheme is legitimate, they will manage to do, and stipulate that the costs shall be met by them if their representations are false. This is a very efficacious method of winnowing chaff from grain in the steady succession of seductive mining schemes with which investors are tempted.

The plan is business-like, except that there may be room for argument over the definition of the word "false." A method which excludes possibility of misunderstanding is for the offerers to deposit or guarantee the money to cover the expense of examination, to be paid in case the sale is not effected. This is sometimes done, and it presupposes the vendors to be not only able to pay but confident in their representations. A compromise plan would be to make the settlement contingent upon the expert's report being favorable or adverse; but this again may admit of uncertainty, for many reports are in the nature of straddles. It is not every expert who will go on record with a definite, flat-footed yes or no opinion on a given proposition, which however is what the investor wants.

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In the body of the index the initials of the papers quoted are given, and these can be readily identified by the alphabetical list of periodicals. Other abbreviations are: Ill=illustrated. W=words.

LIST OF PERIODICALS REGULARLY INDEXED.

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An....American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A CJ....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D... ..American Druggist. *m* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H .....Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York
A M .....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am M....American Miller. *m.* $2. Chicago.
Am S ...American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B B .....Brick Builder. *m.* $2.50. Boston.
B C .....Boston Commonwealth. *w.* $2.50.
B & D...The Builder and Decorator. *m.* $2. Minneapolis.
B G S .. Bulletin of the American Geographical Society. *q* $5. N. Y.
B I S.....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1 per year. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A. Canadian Architect. *m.* $2. Toronto.
C & B .. Carpentry and Building. *m.* $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Electrical News. *m.* $1 per year. Toronto.
Ch .....Chautauquan. *m.* $2. Meadville, Pa.
C M .....Century Magazine. *m.* $4 per year. N. Y.
Cos .... Cosmopolitan. *m.* $3 per year. New York.
D E .....Domestic Engineering. *m.* $1. Chicago.
D J .. ..Drainage Journal. *m.* $1. Indianapolis.
D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A .....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E M .....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N.....Engineering News *w.* $5 per year. N. Y.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
E P D ...Electrical Progress and Development. $2. Boston.
E R .....Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W.....Electrical World. *w.* $3 per year. N. Y.
F .....Forum. *m.* $5 per year. New York.
F D .....The Foundry. *m.* $1. Detroit.
F M.....Farm Machinery. *m.* $1. St. Louis.
F W .....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w* $4 per year N. Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A .....Inland Architect. *m* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age *w.* $4.50. N. Y.
I R W...India Rubber World. *m.* $3 per year. N. Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A..... ..Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S..Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W.Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J P E.....Journal of Political Economy. *q.* $3. Chicago.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L F M...Locomotive Firemen's Magazine. *m.* $1. Terre Haute, Ind.
L M .....Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P .....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min .....Minerals. *m.* $1 per year. N. Y.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .. ..National Builder. *m.* $3. Chicago.
N B D. .Northwestern Builder and Decorator. *m.* $2. Minneapolis.
N C B...National Car Builder. *m.* $2. N. Y.
N M ...Northwestern Mechanic. *m.* $1. Minneapolis.
N W.....Northwestern Architect. *m.* $3. Minneapolis.
O M .....Overland Monthly. *m.* $3 per year. San Francisco.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P..... ..Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
P A .....Progressive Age. *s-m.* $3. New York.
P D.. ...Painting and Decorating. *m.* $1. Phila.
P E. .....Practical Electricity. *f.* $2 per year. Boston.
P E C P..Proceedings of the Engineers' Club. *q.* $2 Phila.
P Era... Pharmaceutical Era. *s-m.* $2. Detroit.
P L .....Pacific Lumberman, Contractor, and Electrician. *w.* $3. San Francisco.
P M. . .Paper Mill. *w.* $3. N. Y.
P R.....Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S ...Power-Steam. *m* $1 per year. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
R A.....Railway Age. *w.* $4 per year. Chicago
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R C J....Railroad Car Journal. *m.* $1 per year. N.Y.
R G .....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M..Railway Master Mechanic. *m* $1. Chicago.
R of R...Review of Reviews. *m.* $2.50. N. Y.
R P.....Registered Pharmacist. *w.* $1. Chicago.
R R.....Railway Review. *w.* $4 per year. Chicago.
R S P....Rudder, Sail and Paddle. *m.* $2. N. Y.
R T .....Rose Technic. *m.* $1. Terre Haute, Ind.
R & T....Roofer and Tinner. *m.* $1 per year. N. Y.
R'y N.....Railway News. *m.* $2. N. Y.
S... .....Stone. *m.* $2 per year. Indianapolis, Ind.

S A.....Southern Architect. *m.* $1. Atlanta.
San.....Sanitarian. *m.* $4 per year. Brooklyn.
Sc.....Science. *w.* $3.50 per year. New York.
Sc A.....Scientific American. *w.* $3. N. Y.
Sc A S...Scientific American Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
S E.....Stationary Engineer. *w.* $2. Chicago.
Sea.....Seaboard. *w.* $2 per year. N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S Era... Sanitary Era. *m.* $1 per year. N. Y.
S J E....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
So L.....Southern Lumberman. *s-m.* $2. Nashville, Tenn.
S M Q.. .School of Mines Quarterly. $2. N. Y.
S P.....Sanitary Plumber. *s-m.* $1. N. Y.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. N. Y.
S R R....Street Railway Review. *m.* $2. Chicago.
S V..... Safety Valve. *m* $1 per year. N. Y.
T ..... Trade-man *s-m.* $2. Chattanooga, Tenn.
T A I E E. Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
W E.. Western Electrician *w.* $3 Chicago.
W F E E. World's Fair Electrical Engineering. *m.* $3. Chicago.

THE FOREIGN PRESS.

A L ....The Architect. *w.* 26*s.* London.
A M S.. Australian Mining Standard. *w.* 30*s.* per year, postpaid. Sydney, Australia.
B A.... .The British Architect. *w* .3*s.* 8*d.* London.
C G.... ..Colliery Guardian. *w.* 27*s.* 6*d.* per year, post-paid. London.
C R.....Contemporary Review. *m.* $4.50 per year, New York. London.
C T J....Chemical Trade Journal. *w.* 12*s.* 6*d.* per year, post-paid. Manchester, Eng.
D. ..... Discovery. *w.* 8*s.* 8*d.*, post-paid. London.
E.....Engineering. *w.* 36*s.*, post-paid. London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year, post-paid. London.
E G.....Engineers' Gazette. *m.* 4*s.*, post-paid. London.
E L.....Electricity. *w.* 6*s.* 6*d.*, post-paid. London.
El. .....Electrician. *w.* 24*s.* post-paid. London.
Elec.....Electricité. *w.* 15 *fr.* post-paid. Paris.
El P .....Electricien. *w.* 25 *fr.* post-paid. Paris.
Eng L... Engineer. *w.* 36*s.*, post-paid. London.
E P.....Electrical Plant. *m.* 6*s.* per year, post-paid. London.
E R L.....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
F R.....Forinightly Review. *m.* $4.50 per year. New York. London.
G C.....Génie Civil. *w.* 45 *fr.*, post-paid. Paris.
G E M...Gas Engineers' Magazine. *m.* 6*s.* 6*d.* per year, post-paid. Birmingham, Eng.
G W.....Gas World. *w.* 13*s.*, post-paid. London.
I.....Iron. *w.* 30*s* per year, post-paid. London.
I & S.....Iron and Steel Trades' Journal. *w.* 25*s.*, post-paid. London.
I C B.....Illustrated Carpenter and Builder. *w.* 8*s.* 8*d.* per year, post-paid London.
I C T.... Iron and Coal Trades' Review. *w.* 30*s.* 4*d.*, post-paid. London.
I E.....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I Eng....Indian Engineer. *w.* Rs. 15 per year, postage extra. Calcutta.
I L. .....Industries. *w.* 32*s.*, post-paid. London.
Inv ..Invention. *w.* 28*s.*, post-paid. London.
J G L....Journal of Gas Lighting. London.
J S A....Journal of the Society of Arts. *w.* London.
K.....Knowledge. *m.* 3*s.*, post-paid. London.
M.....Machinery. *m.* 9*s.*, post-paid. London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* per year, post-paid. London.
M E & E J. Manufacturers' Engineering and Export Journal. *m.* London.
M I.....Moniteur Industriel. *s-w.* 40 *fr* per year, post-paid. Paris.
Min W..The Mining World. *w.* 21*s.* post ex London.
M W.....Mechanical World. *w.* 8*s.* 8*d.* per year, post-paid. London.
N..... Nature. *w.* $7, post-paid. London.
N C.....Nineteenth Century. *m.* $4.50 per year. New York. London.
P Eng...Practical Engineer. *w.* 10*s.* per year, post-paid. London.
Pl D .....Plumber and Decorator. *m.* 6*s.* 6*d.*, post-paid. London.
Rev R...Review of Reviews. *m.* $2.50. New York. London.
R N.....Railway News. London.
R R L...The Railway Review. *w.* London.
R U M...Revue Universelle des Mines. *m.* 40 *fr.* per year, post-paid. Paris.
R W.....Railway World. *m.* 8*s.* post-paid. London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* London.
W R.....Westminster Review. *m.* $4.50 per year. N. Y. London.

ARCHITECTURE.

*9656. The Relations of the Architect to the Engineer. George Hill (E Mag-March.) 3000 w.

†9677. Gwyther's Patent Ventilated Roofs and Floors. Ill. (I E-Dec. 10.) 450 w.

*9692. Revolution in Building. Ill. (S R-Jan. 1.) 1400 w.

*9701. A Sea of Glass. Ill. Caryl Coleman (A R-Jan-March.) 9000 w.

*9702. Mosaic as an Independent Art. Ill. Isabella Bebarbieri (A R-Jan-March.) 2000 w.

*9704. The Modern House in Paris. Ill. Paul Frantz Marcou (A R-Jan-March.) 4000 w.

*9705. Architectural Aberrations.—The Government Building at the World's Fair. Ill. (A R-Jan-March.) 1800 w.

*9707. On the Religious Aspect of Architecture. R. A. Cram (A R-Jan-March.) 9000 w.

*9718. J. B. Huet. Ill. (A L-Jan. 6.) 1500 w.

*9719. French Gothic. Ill. (A L-Jan. 6.) 2200 w.

*9720. Japanese Stencils. Ill. (A L-Jan. 6.) 1000 w.

*9721. Some Renaissance Towers, and Their Ancestry (A L-Jan. 6.) 2500 w.

*9722. The History of Joan of Arc. Ill. (A L-Jan. 6.) 3300 w.

*9723. Westminster Cloisters and National Memorials. Ill. (A L-Jan. 6.) 1500 w.

*9724. Gray's Journey to Italy (A L-Jan. 6.) 2600 w.

*9726. Suggestions for Designs from Foliage —The Celery Ill. (Pl D-Jan. 2.) 900 w.

*9727. A Chat about Walls. W. N. B. (Pl D-Jan. 2.) 1500 w.

9779. Stone in Egypt, Greece, and Italy (M S R-Jan. 12.) 550 w.

9840. An Architectural Compromise. William Nelson Black (A A-Jan. 21.) 3000 w.

9841. Six Hours in Salem. Ill. Claude Fayette Bragdon (A A–Jan. 21.) 3500 w.

†9853. "Architecture a Profession or an Art"? Lord Grimthorpe (N C–Jan.) 9000 w.

9862. Proportions of Churches (A & B–Jan. 21.) 600 w.

†9875. Review of Mrs. Schuyler Van Rensselaer's "English Cathedrals" (A Rev–Aug. 1.) 4000 w.

*9876. The Duties and Responsibilities of Architects. W. J. Jennings (B A–Jan. 13.) 5300 w.

*9887. New Philadelphia. Ill. Charles Morris (L Mag–Feb.) 3000 w.

9903. America's Finest Church (S A–Jan.) 700 w.

9904. St. Joseph's Church, New Orleans. J. C. H. (S A–Jan.) 800 w.

†9944. To the Memory of Gottfried Semper. Ill. (I A–Jan.) 2500 w.

*9945. The Florentine Artist. Ill. E. H. and E. W. Blashfield (Sc M–Feb.) 7300 w.

9956. The Industrial Architect of Cities (A S–Jan. 21.) 1000 w.

*9960. The Ownership of Plans (C A–Jan.) 900 w.

*9975. Bricks and Brickwork. John Slater (B B–Nov-Dec.) 4500 w.

*9976. The Chateau of Maintenon. Ill. (B B–Nov-Dec.) 800 w.

*9989. Stone Floors. Ill. Louis H. Gibson (S–Jan.) 1400 w.

*9992 The Strength and Weathering Qualities of Roofing Slates. George P. Merrill (S–Jan.) 1200 w.

*10002. Architecture in Hamilton. C. H. Acton Bond (Can A–Jan.) 1000 w.

*10003. Notes by a Canadian Architectural Student in London (Can A–Jan.) 2500 w.

*10004. The Entrance Door. John Gammell (Can A–Jan.) 1000 w.

*10005. Some Experiences of a Student in Venice (Can A–Jan.) 2500 w.

*10006. American Architectural Methods from the Standpoint of a Canadian. J. C. B. Horwood (Can A–Jan) 2400 w.

*10007. Notes on Quebec Architecture (Can A–Jan.) 1500 w.

†10039. An Indian Method of Constructing Arches. Ill. (I E–Dec. 24.) 500 w.

*10082. The Hygiene of Building Materials (A H–Feb.) 1500 w.

10083. Tennessee Marbles (C B T–Jan. 28.) 700 w.

*10133. Spanish Architecture. Andrew N. Prentice (B A–Jan. 20.) 1200 w.

10235. An Architect's Home. Ill. (A A–Feb. 4.) 1400 w.

10236. Burned Clay as Roofing Material. John R. Elder (A A–Feb. 4.) 3800 w.

10241. Should Buildings Be Limited? J. W. Smith (F W–Feb. 4) 2000 w.

10242. Strength of Wooden Floors. Special Cases. Ill. F. E. Kidder (A & B–Feb. 4.) 1000 w.

*10279. What Is Architecture, and How Can It Be Advanced? George Aitchison (B A–Jan. 27.) 8000 w.

*10280. Notes on the Pyrenees. Ill. J. P. Consterdine (B A–Jan. 27.) 1100 w.

†10323. Discussion on "The Strength and Weathering Qualities of Roofing Slate." George P. Merrill and Edward H. Williams, Jr. (T C E–Dec.) 1200 w.

10333. Luther's Church in Wittenberg. Ill. (Sc A S–Feb. 11.) 1500 w.

10366. New Building for the Brooklyn Institute (E N–Feb. 9.) 1100 w.

10397. The English Method of Obtaining Tenders. Surveyor (A A–Feb. 11.) 900 w.

10398. An English Humorist on American Architecture (A A–Feb. 11.) 800 w.

†10400. The Proposed Tilden Trust Library for New York City. Ill. Arthur J. Dillon (A Rev–Sept. 12.) 2500 w.

*10404. Architecture in Cities. Barr Ferree (N W–Jan.) 5000 w.

*10421. Outbuildings. Edward Hurst Brown (B & D–Jan.) 1600 w.

*10489. Suggestions for Designs from Foliage—The Groundsel. Ill. (Pl D–Feb. 1.) 1700 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A–Began Feb. 20, 1892—18 parts to date–15 cts. each).

2539. Byzantine Architecture. Ill. Prof. Aitchison (A R–Began Jan-March, 1892—5 parts to date—30 cts. each).

7121. Office-Help for Architects. George Hill (A A–Began Oct. 8—6 parts to date—15 cts. each).

7421. French Cathedrals. Ill. Barr Ferree (A R–Began Oct-Dec.—2 parts to date—30 cts. each).

8881. Japanese Architecture in Chicago. P. B. Wight (I A–Began Dec.—2 parts to date —45 cts. each).

8903. Impressions of a Decorator in Rome. Ill. Frederic Crowninshield (Sc M–Began Jan.—2 parts to date—30 cts. each).

9838. The Ile-de-France School of Architecture. Ill. Anthyme Saint Paul (A A–Began Jan. 21—Ended Feb. 11—4 parts—15 cts. each).

9361. A Glimpse of Scandinavian Architecture on Scenery. Ill. Theodore de Lemos (A & B–Began Jan. 21—Ended Jan. 28—2 parts —15 cts. each).

9874. The Historic Styles and Modern Architecture. Henry Van Brunt (A Rev–Began Aug. 1—1 part to date—45 cts).

10063. Some Mysteries of Modern Architecture. Paul Waterhouse (A & B–Began Jan. 28—Ended Feb. 11—2 parts—15 cts. each).

10290. Notes on the Use of Iron and Steel in Building Construction. J. W. Sashcroft (I–Began Jan. 27—1 part to date—30 cts).

CIVIL ENGINEERING.

†9680. The Road Movement. Ill. Lewis M. Haupt (J F I–Jan.) 5000 w.

*9730. Cockatoo Island Dry-Dock Caisson. Ill. (Eng L–Jan. 6.) 400 w.

*9731. Civil Engineering. Editorial (Eng L–Jan. 6.) 3500 w.

*9736. Harbors and Waterways. Editorial (Eng L–Jan. 6.) 3000 w.

9809. The Great Jetties at the Mouth of the Brazos River. Ill. Walfred W. Wilson (Sc A–Jan. 21.) 700 w.

9825. The Letting of Highway Bridges (E N–Jan. 19.) 1100 w.

9831. Reconstruction of the Philadelphia Water Front (E R–Jan. 21.) 1200 w.

9863. For One All-American Canal. Editorial (I T R–Jan. 19.) 600 w.

*9920. The Improvement of the Seine, and the Rise of the Port of Rouen. Ill. (Eng L–Jan. 13.) 1400 w.

9952. Highway Bridge Building in California. J. D. Galloway (R T–Jan.) 950 w.

*9990. Hydraulic Cement at Milwaukee. Ill. A. E. Baxter (S–Jan.) 1200 w.

10012. Ethics for Civil Engineers. S. Whinery (E N–Jan. 26.) 8900 w.

10014. Retaining Wall Theory and Practice. Editorial (E N–Jan. 26.) 1600 w.

10015. The Austin Dam. Ill. E. W. Groves. With Report of the Austin Board of Public Works (E N–Jan. 26.) 3500 w.

10023. Personal Errors in Cement Testing (E R–Jan. 28.) 600 w.

10024. Improvements of the Great Kanawha River (E R–Jan. 28.) 500 w.

10044. The Nicaragua Canal and American Shipping. S. H. North (E M J–Jan. 28.) 1000 w.

*10072. Recent Investigations on Hydraulic Mortars (Eng L–Jan. 20.) 1800 w.

10098. Piles and Pile Driving. Ill. Julien A. Hall (R R–Jan. 28) 1000 w.

†10128. Madras Harbor. Editorial (I E–Dec. 31.) 1000 w.

†10142. Recollections of the Panama Canal Congress. D. Ammen (N A R–Feb.) 5300 w.

†10143. Government Aid to the Nicaragua Canal. John T. Morgan (N A R–Feb.) 4000 w.

*10146. Discussion of Thomas Appleton's Paper—"Cedar Block Paving" (J A E S–Dec.) 8800 w.

10180. Street Paving—The Movement in this Direction in the South (T–Feb. 1.) 1800 w.

10197. Prize Design for the Duluth Ship Canal Tunnel. Ill. (E N–Feb. 2.) 900 w.

10202. Bridge Piers in the North River. Editorial (E N–Feb. 2.) 1500 w.

10214. The Deep Waterway and the Harbors of Lake Erie. George Y. Wisner (R G–Feb. 3.) 1800 w.

10248. New York's Big Bridge Projects (I T R–Feb. 2.) 1000 w.

*10256. The Growth and Condition of the Roads Question—What the League Has Done to Advance It. Ill. George A. Perkins (G R–Jan.) 1600 w.

*10257. Massachusetts Roads. Ill. W. E. McClintock (G R–Jan.) 3000 w.

*10258. The Need of Trained Road-Makers. Ill. Nathaniel S. Shaler (G R–Jan.) 900 w.

*10259. Good Work in Lenox, Mass. Ill. (G R–Jan.) 2000 w.

*10300. The Proposed Channel Bridge. Ill. (Eng L–Jan. 27.) 3000 w.

*10313. Brick Street Pavements, from Start to Finish. William Steyh (P–Feb.) 14000 w.

*10316. Asphalt of Trinidad. W. P. Pierce (P–Feb.) 3300 w.

†10317. The Controverted Questions in Road Construction, with Discussion (T C E–Dec.) 11500 w.

†10322. Continued Discussion on Thin Floors for Bridges. A. F. Robinson (T C E–Dec.) 1200 w.

10381. Strengthening Bridges While in Use (R G–Feb. 10.) 900 w.

10384. The Nicaragua Canal (R G–Feb. 10.) 600 w.

10407. Asphalt Construction. Ill. (E R–Feb. 11.) 2500 w.

10423. Practice vs. Theory—The Terre Haute Bridge Failure. Quinton McNab (R R–Feb. 4.) 1800 w.

*10457. Failure Under Test Load of Road Bridge over the River Morawa. Ill. (E–Feb. 3.) 1600 w.

Serials.

7061. Maximum Stresses from Moving Single Loads in the Members of Three-Hinged Arches. Ill. Einrick A. Werner (J F I–Began Oct.—Ended Feb.—5 parts—45 cts. each).

9523. Maintenance of Roads in France. Arthur Lagron (P–Began Jan.—2 parts to date—30 cts. each).

9740. Proposed New Road-Bridge across Darling Harbor, Sydney. Ill. (I L–Began Jan. 6—3 parts to date—30 cts. each).

10455. The Bridges of the Manchester Ship Canal (E–Began Feb. 3—1 part to date—30 cts).

ELECTRICAL MISCELLANY.

†9686. Recent Improvements in d'Arsonval Galvanometers. Ill. Nelson H. Genung (J F I–Jan.) 4400 w.

†9687. Errors in the Determination of Areas from Measured Diameters. O. T. Louis (J F I–Jan.) 800 w.

*9711. The Supply of Electricity in Liverpool. Ill. (E R L–Jan 6.) 6000 w.

*9733. Electrical Engineering. Editorial (Eng L–Jan. 6.) 4000 w.

*9761. Sub-Station Transformer Switches. Gerald Stoney (El–Jan. 6.) 800 w.

9763. Works of the Crocker-Wheeler Company. Ill. (E N Y–Jan. 18.) 1000 w.

*9765. Standard Cells and Testing Batteries. Desmond G. Fitzgerald (E E L–Jan. 6.) 1100 w.

*9766. The Distributing Mains of Electric Supply Companies. E. R. Dolby (E E L–Jan. 6.) 900 w.

*9768. Popularizing Electricity. H. J. Dowsing (E E L–Jan. 6.) 1200 w.

*9769. The Manufacture of Electricity in the Future. A. A. Campbell Swinton (E E L–Jan. 6.) 900 w.

*9770. The Supremacy of Newcastle-on-Tyne as a Provincial Centre of Electrical Industry. R. W. Weekes (E E L–Jan. 6.) 1200 w.

*9795. Received 550 Volts and Lives (S R R–Jan.) 1200 w.

*9801. Insulation of Coils. Ill. (S R R–Jan.) 800 w.

9805. Alternating Current Motors.—Recent Invention of Chas. S. Bradley (E R N Y–Jan. 21.) 1200 w.

9816. Electric Power on the Canals (Ir Age–Jan. 19.) 700 w.

*9842. Some Practical Phases of Electricity. Franklin Leonard Pope (Ch–Feb.) 2800 w.

9854. Construction and Operation of Electric Fountains. Ill. (E W–Jan. 21.) 3000 w.

9855. "Electrical Needs of the Times." H. Franklin Watts (E W–Jan. 21.) 1400 w.

9856. Recent Progress in the Introduction of the Triphase System. Ill. (E W–Jan. 21.) 1700 w.

9857. Werner Von Siemens: Some Additional Details Regarding His Life and Work (E W–Jan. 21.) 2800 w.

9859 Report of the Sub-Committee on Provisional Programme for the International Electrical Congress (E W–Jan. 21.) 3500 w.

9868. Cooking and Heating by Electricity. Ill. (Met W–Jan. 21.) 750 w.

*9884. 15-Ton Electric Traveling Crane. Ill. (E–Jan. 13.) 900 w.

*9907. The Life and Inventions of Edison (E R L–Jan. 13.) 700 w.

*9908. Alternating Currents and the Divided Circuit. Ill. Arthur Whitwell (E R L–Jan. 13.) 900 w.

*9909. Experiments with High Frequency Electric Discharges. A. A. Campbell Swinton (E R L–Jan. 13.) 1200 w.

*9911. Thwaite's Scheme for the Transmission of E. M. F. Generated at the Coal Fields. —Mr. Thwaite's Reply (E R L–Jan. 13.) 3000 w.

9918. Some Mechanical and Electrical Analogies. F. Bedell and A. C. Crehore (R R–Jan. 21.) 400 w.

*9919. Electricity in the United States (Eng L–Jan. 13.) 3300 w.

*9930. Central Station Statistics. J. Hesketh (E E L–Jan. 13.) 1000 w.

*9937. The Impedence of Branched Circuits Ill. Alexander Russell (El–Jan. 13.) 1000 w.

*9939. Oil Transformer Experiments. Elihu Thomson (El–Jan. 13.) 600 w.

9950. Standardization of Electrical Measurements. Thomas Gray (R T–Jan.) 1800 w.

9959. The Stanley Transformer. Ill. (E W–Jan. 28.) 700 w.

9961. The Electric Torpedo Detector (E R N Y–Jan. 28.) 500 w.

9963. Tesla's Experiments Simplified. V. (E R N Y–Jan. 28.) 400 w.

9964. Electrical Forging of Round Shapes. Ill. (E R N Y–Jan. 28.) 600 w.

9978. The Subject of Fire Risks. Walter F. Smith (E N Y–Jan. 25.) 800 w.

10052. Electrical Developments Around Hampton Roads. A. Jeffers (M R–Jan. 27.) 1000 w.

*10112. Clamond's Microphone. Ill. E. Uldall (E E L–Jan. 20.) 300 w.

*10115. Some Recent Experiments with an Induction Coil. Ill. Magnus Maclean (El–Jan. 20.) 800 w.

*10117. The Development and Transmission of Power from Central Stations. Ill. W. C. Unwin (El–Jan. 20.) 4500 w.

*10123. Should Electrical Engineers Be Skilled Mechanical Engineers? S. F. Walker (E R L–Jan. 20.) 750 w.

*10125. The Electrical Properties of Pure Substances (E R L–Jan. 20.) 800 w.

*10126. Rotating Electric Field, and Rotations Due to Electrostatic Hysteresis. Ill. Riccardo Arno (E R L–Jan. 20.) 2200 w.

10137. The Dynamo of the Detroit Electrical Works, Detroit, Mich. Ill. (M S R–Jan. 26.) 800 w.

10155. The Physiological and Other Effects of High Frequency Currents. Nikola Tesla (E E N Y–Feb. 1.) 900 w.

10168. Electric Heating. G. Emil Hesse (E A–Feb. 4.) 900 w.

10172. Magnetometric Method of Measuring Losses in Iron Under Alternating Currents. Ill. J. E. Moore (E W–Feb. 4.) 1000 w.

10173. Electrical Measurements. George Black (E W–Feb. 4.) 1250 w.

10174. Probabilities as to the Success of Distribution of Power at Considerable Distances by High Tension Currents of Electricity. E. Carl Breithaupt (E W–Feb. 4.) 1800 w.

10175. Underground Construction. W. A. Tower (E W–Feb. 4) 1100 w.

10178. Electrical Needs of the Times. Lewis T. Robinson (E W–Feb. 4.) 500 w.

10183. Electricity in a Small Arms Factory (Ir Age–Feb. 2.) 1600 w.

10184. Electrical Furnaces for Experimental Research (Ir Age–Feb. 2.) 900 w.

10224. Non-Synchronous Motor for Ordinary Alternate Currents. Ill. C. E. L. Brown (W E–Feb. 4.) 2700 w.

*10263. How Can the Department of Electricity of the World's Columbian Exposition Best Serve the Electrical Interests?—The $100 Prize Essay. Herbert Laws Webb (W F E E–Feb.) 1600 w.

*10273. Brown's Alternate Current Motor. Ill. (I L-Jan. 27.) 700 w.

*10274. The Electric Furnace (I L-Jan. 27.) 700 w.

10278. Electricity in the Kitchen. Editorial (E R N Y-Feb. 11.) 700 w.

*10282. Portative Electrical Energy. J. T. Niblett (E E L-Jan. 27.) 9000 w.

*10284. Malleable Cast Iron for Field Magnets. Ill. (E E L-Jan. 27.) 250 w.

*10287. Notes on Central Station Working. Ill. W. Brew and P. G. Ledger (E E L-Jan. 27.) 5000 w.

*10298. Thermal Storage. Ill. (Eng L-Jan. 27.) 1200 w.

*10302. The Lauffen-Heilbrown Transmission. Ill. (El-Jan. 27.) 600 w.

10309. A Scrap of Electric Gas Lighting History. Ill. (E N Y-Feb. 8.) 1800 w.

10311. A Mechanical Theory of Magnetism (E N Y-Feb. 8.) 1300 w.

10324. Heating Effects of Alternating Currents. Ill. A. D. Lunt (E W-Feb. 11.) 700 w.

10343. A Method of Correcting the Regulation Curves of Generators. George L. Thayer (E E N Y-Feb. 8.) 500 w.

10356. Improved Storage Cells (S E-Feb. 4.) 700 w.

10357. Underground Construction, with Discussion. W. A. Tower (C E N-Feb.) 3000 w.

10363. German Electric Elevator. Ill. (W E-Feb. 11.) 500 w.

*10459. Measurement of Alternating Electric Currents. Ill. J. A. Fleming (E-Feb. 3.) 1650 w.

*10460. The Development and Transmission of Power from Central Stations. Prof. Unwin (E-Feb. 3.) 3500 w.

10468. Transmission of Power by Direct Currents.—Some new and valuable improvements by Charles S. Bradley (E R N Y-Feb. 18.) 1650 w.

10473. Some Experiments with Disruptive Discharges. Ill. Alexander Jay Wurts (E E N Y-Feb. 15.) 2000 w.

*10484. Thermal Storage Voltampere (Eng L-Feb. 3.) 1600 w.

*10493. Internal Transmission of Power. B. H. Thwaite (E R L-Feb. 3.) 2000 w.

*10494. On the Measurement of the Magnetic Properties of Iron. Abstract of Paper by Thomas Gray (E R L-Feb. 3.) 550 w.

Serials.

2784. Insulated Electric Conductors. James Bowstead Williams (E E N Y-Began March 16—18 parts to date—15 cts. each).

5543. Light and Power Stations. Robb Mackie (E R N Y-Began July 23—13 parts to date—15 cts. each).

8905. Sparking at Commutators. Ill. F. M. Weymouth (El-Began Dec. 9—5 parts to date—30 cts. each).

9373. New York's Electrical Subways. Ill. William Maver, Jr. (E E N Y-Began Jan. 4—Ended Jan. 25—4 parts—15 cts. each).

9374. Laminated or Divided Iron and Other Metallic Masses in Electromagnetic Apparatus. Thomas D. Lockwood (E E N Y-Began Jan. 4—7 parts to date—15 cts. each).

9712. The Power Plant. Fred De Land (W F E-Began Jan.—Ended Feb.—2 parts—30 cts. each).

9713. Alternating Current Apparatus (W F E-Began Jan.—2 parts to date—30 cts. each).

9771. What is Electricity? S. F. Walker (E E L-Began Jan. 6—2 parts to date—30 cts. each).

9858. The Calculation of Alternating Current Motors. Ill. E. Arnold (E W-Began Jan. 21—1 part to date—15 cts).

9928. Points of Construction in Underground Mains. Alfred H. Gibbings (E L-Began Jan. 13—2 parts to date—30 cts. each).

9957. Ether and Electricity. A. Stolelow (E W-Began Jan. 28—3 parts to date—15 cts. each).

10147. William Wallace and His Contributions to the Electrical Industries. Ill. W. J. Hammel (E E N Y-Began Feb. 1—3 parts to date—15 cts. each).

10170. Electrical Oscillation of High Frequency. Ill. Ervin S. Ferry (E W-Began Feb. 4--2 parts to date—15 cts. each).

10325. The Electrical Side of St. Louis, Ill. (E W-Began Feb. 11--1 part to date—15 cts).

10464. The Silver Plating Industry. Ill. (I L-Began Feb. 3—1 part to date—30 cts).

ELECTRIC LIGHTING.

*9669. Improved Lithanode Storage Batteries. Ill. (E G-Jan.) 1300 w.

*9767. Metal vs. Wood-Casing. W. B. Sisling (E E L-Jan. 6.) 600 w.

*9905. Central Electric Light Stations. Ill. (E R L-Jan. 13.) 900 w.

*9910. Steam Power from House Dust for Electric Lighting (E R L-Jan. 13.) 800 w.

*9933. A Typical Electric Lighting Station. Edward T. Stuart-Menteath (Inv-Jan. 14.) 1900 w.

9974. How Edison Obtained the Key to Perfect Light. E. Jay Edwards (P E-Jan. 21.) 1000 w.

9982. The Carbon Filament Lamp of 1859.—The Story of an Overlooked Invention. Ill. Franklin L. Pope (E E N Y-Jan. 25.) 3000 w.

9986. Incandescent Lamp Litigation—Henry Goebel, a New Claimant for Priority. G. M. P. (E E N Y-Jan. 25.) 4000 w.

10009. Is the Edison Lamp Patent Void? (E N Y-Jan. 26.) 6000 w.

10017. The Thomson Recording Water Meter. Parmalee J. McFadden (W E-Jan. 28.) 2000 w.

10018. Edison Meter. John F. Gilchrist (W E-Jan. 28.) 2200 w.

*10116. Hopkinson's Three-Wire Patent. Editorial (El-Jan. 20.) 1700 w.

*10119. Modern Ship-lighting. Ill. (E L-Jan. 20.) 1200 w.

*10121. Electric Street-Lighting in American Cities.—The Question of Municipal vs. Private Supply. Robert J. Finley (R of R-Feb.) 1800 w.

10151. Goebel. Editorial (E E N Y-Feb. 1.) 900 w.

10154. Incandescent Lamp Litigation.—The Goebel Defense (E E N Y-Feb. 1.) 1800 w.

10157. Electric Meters. John F. Gilchrist (E N Y-Feb. 1.) 3000 w.

10171. The Economy of Incandescent Lamps. L. K. Böhm (E W-Feb. 4.) 1200 w.

10176. The Incandescent Lamp. R. G. Black (E W-Feb. 4.) 1200 w.

10222. Discussion of Electric Meter Papers Read by Messrs. Macfadden, Gilchrist, and Wirt (W E-Feb. 4.) 3000 w.

10223. Invention of the Incandescent Lamp. Foree Bain (W E-Feb. 4.) 700 w.

10226. Electric Light Candle Powers (M N-Feb. 1.) 700 w.

10260. The Beacon Vacuum Pump and Electrical Company Strengthen Their Case.—New Evidence (E N Y-Feb. 6.) 8000 w.

*10305. The Manufacture of the Volta Incandescence Lamps (E R L-Jan. 27.) 1900 w.

10329. Home-Made Storage Battery for Electric Lighting Purposes. Ill. (E W-Feb. 11.) 1000 w.

10342. Attitude of the General Electric Company (E E N Y-Feb. 8.) 900 w.

10345. Incandescent Lamp Litigation,—and Goebel's Incandescent Lamp and Filament Planer. Ill. (E E N Y-Feb. 8.) 5500 w.

10350. Free Wiring. J. M. Campbell (E A-Feb. 11.) 500.w.

10351. The Incandescent Lamp. Prof. Rosebrugh (E A-Feb. 11.) 1200 w.

10354. Incandescent Lamps.—Their Use, Abuse, and How to Select Them. C. G. Armstrong (S E-Feb. 4.) 2200 w.

10358. The Incandescent Lamp. R. G. Black (C E N-Feb.) 3000 w.

*10406. Aron Meter. Charles Wirt (E I-Feb.) 700 w.

*10439. W. H. Preece on the Progress of Electricity (J G L-Jan. 31.) 4800 w.

*10481. The Deptford Electric Light Station. Ill. (Eng L-Feb. 3.) 2500 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L-Began Sept. 9—13 parts to date—30 cts. each).

8710. Incandescence Lamp Manufacture in the United States. Ill. Leonard G. Tate (E P-Began Dec. 1—2 parts to date—30 cts. each).

9531. Suggestions for Metering Devices. Ill. (E W-Began Jan. 14—3 parts to date—15 cts. each).

9906. Electric Light and Gas. Ed. C. De Segundo (E R L-Began Jan. 13—2 parts to date—30 cts. each).

10403. Evolution of Electric Lighting. W. H. Wakeman (M G-Began Feb. 11—1 part to date—15 cts).

GAS ENGINEERING.

*9665. The Diffusion of Light in Rooms (J G L-Jan. 3.) 3000 w.

*9666. Experiments on the Strength of Gas-holders Constructed of Brown Paper. E. Lloyd Pease (J G L-Jan. 3.) 1200 w.

*9738. Gas Supply. Editorial (Eng L-Jan. 6.) 900 w.

9755. The Bar Photometer (P A-Jan. 16.) 1000 w.

9878. Manufacture of Oil Gas at the Halloway Works, England (A M & I W-Jan. 20.) 1000 w.

*9901. Gas vs. Electricity for Illuminating Purposes, with Editorial (G W-Jan. 14.) 5000 w.

*9902. The Edinburgh Gas (G W-Jan. 14.) 2600 w.

*9913. Review of Paper by J. Emerson Dawson.—"Gas-Power for Electric Lighting" (I & S-Jan. 14.) 1500 w.

*10056. Further Applications of Coal Gas for Heating. Thomas Fletcher (J G L-Jan. 17.) 800 w.

*10057. The Fatal Explosion at the Bradford Gas-Works (J G L-Jan. 17.) 3500 w.

*10060. The Value of Coal Tar (G E M-Jan. 10.) 1200 w.

*10061. Recovery of Ammonia. Isaac L. Bell (G E M-Jan. 10.) 2000 w.

10095. Mr. Addick's Presentation of the Gas Association Problem. Clement A. White (A G L J-Jan. 30.) 3500 w.

10096. The Harris Process for Generating Gas. Frederic Egner (A G L J-Jan. 30.) 1300 w.

*10120. Recent Results of Municipal Gas-Making in the United States. Edward W. Bemis (R of R-Feb.) 6000 w.

*10134. Welsbach Lamps (G W-Jan. 21.) 2000 w.

*10135. The "Yeadon" Process of Carbonization. Ill. (G W-Jan. 21.) 2000 w.

10167. The Rew Apparatus. Ill. (P A-Feb. 1.) 1500 w.

*10191. A Few Remarks on the Possibilities of Incandescent Gas Lighting. H. Leicester Greville (J G L-Jan. 24.) 1400 w.

*10193. A Look into the Distribution Department. Paulos Thieman (J G L-Jan. 24.) 3500 w.

*10306. A Modified Form of Apparatus for the Analysis of Gases. Ill. W. Macfarlane and P. Caldwell (I C T-Jan. 27.) 2500 w.

*10486. The Manufacture of Oil Gas (I & S-Feb. 4.) 1800 w.

*10496. The Calculation of Flame Temperatures. E. Blass (I-Feb. 3.) 1400 w.

Serials.

8834. Experimental Determination of the Heat Generated per Candle Power by Oil and Gas Lamps. D. S. Jacobus (P A–Began Dec. 15—3 parts to date—15 cts. each).

9491. On Sloping Retorts (G W–Began Dec. 31—2 parts to date—30 cts. each).

9792. Experimenting with a View to the Development of Gasholder Construction. Ill. F. Southwell Cripps (J G L–Began Jan. 10—Ended Jan. 31—4 parts—30 cts. each).

HYDRAULICS.

†9685. Artesian Wells as a Water Supply for Philadelphia. Oscar C. S. Carter (J F I–Jan.) 1200 w.

*9691. The Romance of Water Engineering (S R–Jan. 1.) 1400 w.

*9744. Irrigation in Egypt (E–Jan. 6.) 4800 w.

†9750. Prospect of Artesian Boring in Rangoon, with Editorial (I E–Dec. 17.) 900 w.

9803. The Water Power of the Ocmulgee River. Meade Hendrick (T–Jan. 15.) 700 w.

9804. A Runaway Elevator.—Air in the Cylinder (S E–Jan. 14.) 500 w.

9808. The Potsdam Red Sandstone Company's Water Wheel. Ill. (Sc A–Jan. 21.) 900 w.

9828. The High Service Water Works System of New London (E N–Jan. 19.) 1600 w.

9832. Recent Filtration Experience at Lawrence, Mass. (E R–Jan. 21.) 1400 w.

9850. Hydraulic Engineering—Wonderful Advance Made in This Century. Ill. (I Age–Jan.) 500 w.

9867. The Mechanical Aeration of Water. Albert K. Leeds (Eng–Jan. 21.) 1300 w.

9889. A Water Supply Apparatus. Ill. (D E–Jan. 17.) 1000 w.

10028. Filter Plant in a Metropolitan Hotel. Ill. (E R–Jan. 28.) 800 w.

†10087. Rangoon Water Supply Extension Scheme. Ill. (I E–Dec. 24.) 1000 w.

*10069. The London Hydraulic Power Company. Ill. (Eng L–Jan. 20.) 4000 w.

10087. Water After Fifty Years (F W–Jan. 28.) 600 w.

†10127. Rangoon Water Supply Extension Scheme. Editorial (I E–Dec. 31.) 1200 w.

10166. Irrigation in California. B. M. Lelong (M S P–Jan. 28.) 3500 w.

†10209. Laying a Syphone Under Brood Canal, Cambridge. Ill. John L. Harrington (J N E W–Dec.) 1900 w.

†10210. The Effect of the Aeration of Natural Waters, with Discussion. Thomas N. Brown (J N E W–Dec.) 3000 w.

†10211. The Purification of Drinking Water by Sand Filtration. Ill. W. T. Sedgwick (J N E W–Dec.) 12000 w.

10213. Air Chamber, Madison Water Works. Ill. (E R–Feb. 4.) 500 w.

†10318. The Use of Asphaltum for Reservoir Linings. Ill. James D. Schuyler (T C E–Dec.) 4000 w.

10338. Water Wheel and Dam.—History of Holyoke's Dam (P M–Feb. 9.) 2500 w.

10368. The Re-inforcement of Wells. Ill. G. D. Hiscox (E N–Feb. 9.) 1000 w.

10386. The "Long Island Water Supply" Case. Peter Milne (F W–Feb. 11.) 1100 w.

10408. Stand-Pipes and Their Design. Ill. Freeman C. Coffin (E R–Feb. 11.) 4000 w.

†10434. Mr. Doig's Report on the Shone System at Rangoon. Playford Reynolds (I E–Jan. 7.) 900 w.

†10437. Curve of Infiltration in Wells. Ill. G. R. (I E–Jan. 7.) 200 w.

*10456. Irrigation in Egypt. W. Willcocks (E–Feb. 3.) 1000 w.

Serials.

9998. American Turbine Water Wheels. Ill. Samuel Webber (Ir Age–Began Jan. 26—3 parts to date—15 cts. each).

INDUSTRIAL CHEMISTRY.

†9684. The Deposits of Native Soda, near Laramie, Wyoming. H. Pemberton, Jr., and George P. Tucker (J F I–Jan.) 900 w.

*9735. Chemical Industry. Editorial (Eng L–Jan. 6.) 1000 w.

9864. Hermite Electrolytic Bleaching Process. Ill. (W E–Jan. 21.) 1200 w.

*9899. The Analysis of Tin and Terne Plate. R. B. Carnahan (I–Jan. 13.) 500 w.

9977. Electro-Chemical Bleaching.—Report of Mr. De Luynes (E N Y–Jan. 25.) 2000 w.

10247. Chemistry and Foundry Practice. Clemens Jones (I T R–Feb. 2.) 2800 w.

10281. The Biological Examination of Water. Earnest J. Parry (R P–Jan. 15.) 2300 w.

10393. Western Notes for the Instruction of Assayers and Chemists. Stuart Croasdale (E M J–Feb. 11.) 3300 w.

*10491. Electricity for Chemical Laboratories (El–Feb. 3.) 1000 w.

Serials.

4838. The Chemistry of Rubber Ingredients and Adulterants. Ill. Henry J. Williams (I R W–Began Jan.—7 parts to date—30 cts. each).

9814. The Relations of Chemistry to Foundry Practice. Clements Jones (Ir Age–Began Jan. 19—2 parts to date—15 cts. each).

INDUSTRIAL SOCIOLOGY.

*9667. Proposed General Labor Exchange for Great Britain (J G L–Jan. 3.) 1000 w.

†9700. The Social Condition of Labor. E. R. L. Gould (C R–Jan.) 8000 w.

†9716. The Dearness of Cheap Labor. David F. Schloss (F R–Jan.) 4000 w.

†9717. Social Politics in New Zealand. Julius Vogel (F R–Jan.) 6500 w.

*9757. Capitalist Conspirators. Editorial (R R L–Jan. 6.) 1300 w.

*9764. London Chamber of Arbitration. S. Flood Page (E E L–Jan. 6.) 900 w.

*9791. A New South Metropolitan Development (J G L–Jan. 10.) 1200 w.

*9794. As to Wages and Profits (S R R–Jan.) 900 w.

9802. The Industrial Problem in the South. Jos. F. Slater (T–Jan. 15.) 3000 w.

*9843. The Common Road as a Social Factor. Jno. Gilmer Speed (Ch–Feb.) 5000 w.

9870. Social Work at the Krupp Works, Essen, Germany (E M J–Jan. 21.) 2000 w.

†9947. Tariff Reform: Retrospective and Prospective. David A. Wells (F–Feb.) 8000 w.

†9949. A Practical Remedy for Evils of Immigration. Gustav H. Schwab (F–Feb.) 4000 w.

10001. Andrew Carnegie and Henry Clay Frick. T. N. Boyle (B I S–Jan. 25.) 1700 w.

*10054. Cheap and Dear Labor—Editorial on Article by David F. Schloss (J G L–Jan. 17.) 1200 w.

†10078. Compulsory National Arbitration. Rabbi Solomon Schindler (A–Feb.) 1000 w.

10090. Strikers Must Respect Law. Editorial (R A–Jan. 27.) 1200 w.

†10141. How to Revise the Tariff. William M. Springer (N A R–Feb.) 3000 w.

*10271. The Economy of High Wages. Editorial (I L–Jan. 27.) 1200 w.

10394. Our Need of Immigrants. C. J. Haden (M R–Feb. 10.) 2700 w.

†10449. The Limits of Collectivism. William Clarke (C R–Feb.) 8000 w.

*10462. The London County Council and Wages. Editorial (I L–Feb. 3.) 1000 w.

Serials.

9745. American Industries and British Commerce (E–Began Jan. 6—4 parts to date—30 cts. each).

LANDSCAPE ENGINEERING.

10156. A Seventeenth Century Garden (G & F–Feb. 1.) 2000 w.

10268. Boston's Proposed Metropolitan Park System (G & F–Feb. 8.) 1550 w.

10453. Garden-Art and Architecture (G & F–Feb. 15.) 1200 w.

MARINE ENGINEERING.

*9657. Shipbuilding on the Great Lakes. Ill. Henry A. Griffin (E Mag–March.) 3000 w.

*9670. Feeding of Marine Boilers. Valencia (E G–Jan.) 1400 w.

*9729. Atlantic Racing (Eng L–Jan. 6.) 800 w.

*9741. English and American Shipping. Editorial (I L–Jan. 6.) 2000 w.

*9746. Shipbuilding and Marine Engineering in England (E–Jan. 6.) 3500 w.

9810. The Atlantic Ocean: Its Currents. Richard Beynon (Sc A S–Jan. 21.) 3000 w.

9819. Canada's Finest.—Description of the Steamer "Niagara." Ill. (Sea–Jan. 19.) 600 w.

*9886. The Limit of Propeller Efficiency as Dependent on the Surface Form of the Propeller. Ill. W. F. Durand (S J E–Jan.) 2800 w.

*9923. Stay Tubes in Marine Boilers. Editorial (Eng L–Jan. 13.) 1400 w.

9942. Flexible Shafts for Ocean Steamers (M N–Jan. 15.) 500 w.

9987. The Speediest of Her Class. Ill. (Am S–Jan. 26.) 600 w.

9994. An Ice Crusher and War Steamer (Sc A–Jan. 28.) 700 w.

9995. Rudder of the Battle Ship "Oregon." Ill. (Ir Age–Jan. 26.) 350 w.

10008. Fryer Steamship Howard Cassard, with Editorial. Ill. (Sea–Jan. 26.) 3000 w.

10034. The Latest Additions to Our Navy (R G–Jan. 27.) 1000 w.

*10058. The Progress of Ships' Engines Traced and Illustrated. A. J. Mginnis (M–Jan. 15.) 2200 w.

10064. Against the Ship Canal. Extract from a paper by Horatio Seymour, Jr. (M R C–Jan. 26.) 600 w.

*10109. A New System of Construction in Shipbuilding. Editorial (Inv–Jan. 21.) 1700 w.

†10129. Steamer Lakshine, E. I. R. Ill. (I E–Dec. 31.) 200 w.

10161. Gas Engine and Power Company's Works—Where Naphtha Yachts Are Built for All Parts of the World. Ill. (Am S–Feb. 2.) 1600 w.

10162. The Atlantic Works, East Boston. Ill. (Sea–Feb. 2.) 1000 w.

10181. A Danish Naval Trial of Water Tube Boilers (Ir Age–Feb. 2.) 1500 w.

*10189. The Strength of Torpedo Boats. Ill. (E–Jan. 20.) 800 w.

10203. A French Magnetic Towing Device. Ill. (E N–Feb. 2.) 1300 w.

*10227. The Evolution of Naval Construction. Ill. S. Eardley-Wilmot (Cos–Feb.) 4500 w.

10250. A Powerful American Wrecking Tug (M Rec–Feb. 2.) 500 w.

*10272. Engineers in the United States Navy. Editorial (I L–Jan. 27.) 1600 w.

10353. A Unique War Vessel—"Katahdin." Ill. (Sea–Feb. 9.) 1700 w.

10382. The Campania and Lucrania (R G–Feb. 10.) 1500 w.

10414. Pontooning through the St. Lawrence Canals. Ill. (M Rec–Feb. 9.) 400 w.

*10463. The Training of Young Marine Engineers (I L–Feb. 3.) 500 w.

Serials.

9542. Down the Ohio. Ill. Alexander R. Smith (Sea–Began Jan. 12—Ended Jan. 19—2 parts—15 cts. each).

MECHANICAL ENGINEERING.

*9732. Mechanical Engineering. Editorial (Eng L–Jan. 6.) 7000 w.

9837. The Alabama Compress and Storage Company's Plant. Ill. (M R–Jan. 20.) 1200 w.

9897. A New Key and an Old Wheel. Ill. W. H. Wakeman (M G–Jan. 21.) 700 w.

*9900. American Mechanism—Review of Park Benjamin's "Modern Mechanism" (N–Jan. 12.) 2600 w.

9941. Piston Rod Fastenings (M N–Jan. 15.) 450 w.

*10059. Albert's Fire Truck Ladder Described and Illustrated (M–Jan. 15.) 600 w.

10164. Tools for Brass Work. Ill. F. H. Colvin (A M–Feb. 2.) 1800 w.

10195. The Crosby Tubular Iron Derrick. Ill. (E N–Feb. 2.) 400 w.

10204. Wheel Flanges. Ill. Godfrey W. Rhodes (E N–Feb. 2.) 2500 w.

*10220. Riveted Joints. H. de B. Parsons (R A E J–Feb.) 900 w.

*10307. Friction Clutch. H. P. Christie (I S F–Feb.) 1300 w.

10335. Drop Dies—Selection of Steel for—Using and Repairing (A M–Feb. 9.) 2000 w.

10375. Some Things Beyond the Capacity of the Molding Machine. Ill. S. Bolland (F D–Nov.) 3500 w.

10388. About Pulleys (B J C–Feb. 11.) 1300 w.

10420. Shops Operated by Compressed Air. Ill. (R A–Feb. 10.) 700 w.

Serials.

8318. Principles, Curiosities, Possibilities, and Limitations of the Crank Motion. Leicester Allen (Eng–Began Nov. 26—5 parts to date—15 cts. each).

8550. Centrifugal Pumps. Ill. G. R. Bodmer (I L–Began Nov. 25—2 parts to date—30 cts. each).

METALLURGY.

*9659. Locations for Pig-Iron Production. John Birkinbine (E Mag–March.) 3000 w.

†9681. Development and Condition of the Coke Industry by the Utilization of By-Products. Ill. B. Leistikow (J F I–Jan.) 3500 w.

†9682. Haines' Automatic Micrometer Gage for Gaging Either Hot or Cold Rolling Mill Work to Exact Thickness While in the Act of Rolling. R. B. Haines, Jr. (J F I–Jan.) 950 w.

*9734. Metallurgy. Editorial (Eng L–Jan. 6.) 900 w.

*9775. Improvements in the Materials Employed for Casting Metals (Inv–Jan. 7.) 1100 w.

9815. Specimen Tests of Eye-Bars (Ir Age–Jan. 19.) 2700 w.

9869. The Persistence of Ores in Lodes in Depth. T. A. Rickard (E M J–Jan. 21.) 2500 w.

9871. The Fire Refining of Gold and Silver. R. P. Andrews (E M J–Jan. 21.) 700 w.

9877. The Relation of Coal Washing to Iron Manufacture. Walter J. May (A M & I W–Jan. 20.) 1500 w.

*9885. On Some of the Mechanical Properties of High Steel as Related to Its Composition and Structure. Ill. John W. Langley (S J E–Jan.) 1900 w.

*9898. Expressing Analytical Results in Coal and Ore Dressing. Walter J. May (I–Jan. 13.) 1200 w.

9914. Steel vs. Iron—A Night with a Ghost. George Richards (R R–Jan. 21.) 1500 w.

9955. The Volumetric Estimation of Zinc. H. V. F. F. (M I T–Jan. 19.) 1700 w.

9996. The Hugh Kennedy Hot-Blast Stove. Ill. (Ir Age–Jan. 26.) 800 w.

9999. Iron and Steel Industries of the Southern States. William M. Sweet (Ir Age–Jan. 26.) 1800 w.

10000. The Welsh Tin Platers. Editorial (Ir Age–Jan. 26.) 800 w.

10021. The MacArthur-Forrest Process. Almarin B. Paul (M S P–Jan. 21.) 3300 w.

10066. Pressed Zinc Work. Ill. (Met W–Jan. 28.) 2500 w.

*10075. The Selection and Treatment of Steel for Forgings. Francis Rixon (C G–Jan. 20.) 1300 w.

*10080. The Early Struggles of Open-Hearth Steel Making, and of Steel Casting Manufacture. William Shaw (I–Jan. 20.) 3800 w.

*10081. Geological, Manufacturing, and Other Notes on Iron. From paper by Thomas Morris (I–Jan. 20.) 700 w.

*10139. The Invention of Cast Steel (L E–Feb.) 1200 w.

10185. Steel vs. Iron for Machine Construction (Ir Age–Feb. 2.) 550 w.

10186. Coke. Jones Wister (Ir Age–Feb. 2.) 3000 w.

10200. Twenty Years of Progress in the Manufacture of Iron and Steel in the United States—1870-90 (E N–Feb. 2.) 1500 w.

10225. Warped Castings. W. A. Jones (M N–Feb. 1.) 1000 w.

10261. Investigating the Structure of Steels. Ill. (R M M–Feb.) 450 w.

*10288. Progress of the Metallurgy of Nickel. D. Levat (I–Jan. 27.) 2800 w.

*10289. Minerals and Metals in Russia (I–Jan. 27.) 1500 w.

*10292. The Imports of Spanish Iron Ore for 1892, and Some Remarks Thereon. Walter J. May (C G–Jan. 27.) 1100 w.

10337. Foundry Practice with Keep's Tests. Ill. W. J. Keep (A M–Feb. 11.) 2000 w.

10387. Lake Superior Coke Making. R. A. Parker (I T R–Feb. 9.) 1800 w.

10450. Gold Amalgamation Methods (M I T–Feb. 9.) 1200 w.

*10479. Manganese in Siderurgical Products. M. Campredon (C G–Feb. 3.) 1000 w.

Serials.

6033. Variations in the Milling of Gold Ores.

T. A. Rickard (E M J-Began Aug. 27—Ended Feb. 4—7 parts—15 cts. each).

7680. The Freiburg Works, Germany (A M S-Began Sept. 24—8 parts to date—30 cts. each).

8289. The Iron Industry of the British Colonies—Its Position and Prospects (C G-Began Nov. 18—11 parts to date—30 cts. each).

9380. "Keep's Tests" for Cast Iron. Ill. W. J. Keep (A M-Began Jan. 5—Ended Jan. 19—3 parts—15 cts. each).

9435. The Action of Sulphuric and Nitric Acids on Lead of Different Degrees of Purity. George Lunge (E M J-Began Jan. 7—Ended Jan. 21—3 parts—15 cts. each).

9708. The Industrial Value of Aluminum. J. H. J. Dagger (A Ar-Began Jan. 14—2 parts to date—15 cts. each).

9834. Iron and Steel Industries of the Southern States. William M. Sweet (M R-Began Jan. 20—2 parts to date—15 cts. each).

10053. A Contribution to the Southern Coke Problem. Ill. George W. Whyte (M R-Began Jan. 27—2 parts to date—15 cts. each).

10165. Several Ways of Molding a Four-Chambered Ventilator Shaft. Ill. S. Bolland (A M-Began Feb. 2—2 parts to date—15 cts. each).

10254. Manganese Steel. Ill. H. M. Howe (J F I-Began Feb.—1 part to date—45 cts).

10266. Castings. How to Obtain their Measurement and Reckon their Weights, also the Nature and Qualities of the Materials Used in Producing Them. Percentage in the Foundry. Important Facts, Formulas, Tables, etc. S. Bolland (F D-Began Dec.—1 part to date—15 cts).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L-Began Jan. 27—2 parts to date—30 cts. each).

10410. Development of the Coke Industry by the Utilization of By-Products. Ill. (A M & I W-Began Feb. 10—1 part to date—15 cts).

MILITARY ENGINEERING.

*9844. Militarism and Social Reform in Germany. Franz Schumann (Ch-Feb.) 2400 w.

*9921. The Gun Trials of the Twin-Screw, Armor-Clad Ram Libertad (Eng L-Jan. 13.) 1200 w.

10084. Projectile Manufacture in Pittsburg (A M & I W-Jan. 27.) 900 w.

†10144. Needed Reforms in the Army. John Gibbon (N A R-Feb.) 3000 w.

10231. Improved Methods of Compressing Large Bodies of Cast Steel for Guns, etc. Ill. (A M & I W-Feb. 3.) 1900 w.

10331. Trial of the Pneumatic Cruiser, Vesuvius. Ill. (Sc A-Feb. 11.) 1200 w.

10332. Worthless Rifles in the German Army. Ill. (Sc A S-Feb. 11.) 1200 w.

†10427. The Artillery of Siege Warfare. L. G. Berry (J U S A-Jan.) 3000 w.

†10428. A Few Thoughts on Practical Artillery. G. N. Whistler (J U S A-Jan.) 6000 w.

†10429. Target Practice. Ill. Henry C. Davis (J U S A-Jan.) 6000 w.

†10430. A New Percussion Fuse. Ill. Henry P. Merriam (J U S A-Jan.) 2500 w.

†10432. Some Applications of Glennon's Velocity and Pressure Formulas. James M. Ingalls (J U S A-Jan.) 450 w.

†10433. Continued Discussion on "Electricity and the Art of War." C. D. Parkhurst (J U S A-Jan.) 1050 w.

†10448. The Military Courage of Royalty. Archibald Forbes (C R-Feb.) 3600 w.

*10483. Complication in Gunnery. Editorial (Eng L-Feb. 3.) 1250 w.

Serials.

8241. Assault and Battery. A. Ewbank (I E-Began Oct. 22—9 parts to date—45 cts. each).

10431. Field-Artillery Draft. A. D. Schenck (J U S A-Began Jan.—1 part to date—45 cts).

MINING.

*9668. The Great Britain Coal Trade for the Past Year (J G L-Jan. 3.) 2000 w.

*9747. Labors of the Austrian Fire damp Commission. M. G. Chesneau (C G-Jan. 6.) 3300 w.

9780. Prosperous Rico (M S R-Jan. 12.) 700 w.

*9782. The Batavia River Gold Rush. Ill. (A M S-Dec. 3.) 1200 w.

*9783. The Eidsvold Goldfield (Q.) (A M S-Dec. 3.) 1800 w.

*9785. The Wakamarina Gorge Gold Mine (A M S-Dec. 3.) 1800 w.

*9793. The Spontaneous Combustion of Coal (J G L-Jan. 10.) 1700 w.

9835. Improved Transportation Facilities in the Florida Phosphate Region. J. H. Jones (M R-Jan. 20.) 1600 w.

9836. The Fuente Coal Mine (M R-Jan. 20.) 700 w.

*9912. Gold Mining, in the Colar Field of Mysore, India—Its Past, Present, and Future (Min W-Jan. 14.) 2500 w.

*9926. Experiments with Safety Lamps.—Abstract of reports to the French Fire-damp Commission (C G-Jan. 13.) 4000 w.

9951. Ventilation of Coal Mines. E. F. Robinson (R T-Jan.) 900 w.

9953. A Great Old Mine Resurrected (M I T-Jan. 19.) 1200 w.

*9968. The Mount Lyell Mining Company (A M S-Dec. 10.) 750 w.

*9971. Bismuth Mining in Australia. W. Bertrand Roberts (A M S-Dec. 17.) 1500 w.

*9972. The Victoria Junction Mine (Vic.) (A M S-Dec. 17.) 900 w.

*9973. The Butcher's Reef Company. N. L. Maryborough (Vic.) (A M S-Dec. 24.) 1600 w.

10042. The Gold Mines of Mexico. Editorial (E M J-Jan. 28.) 900 w.

10043. The Persistence of Ores in Lodes in

Depth. John F. Blandy (E M J-Jan. 28.) 1000 w.

10045. The Brown Ore Deposit of Baker Hill, Alabama. Ill. William M. Brewer (E M J-Jan. 28.) 1600 w.

10047. Experiments on the Washing of Coal from the Nelson Mine, Tennessee. George W. Whyte (E M J-Jan. 28.) 1200 w.

10048. A Method of Carrying a Survey Line Down Shafts. Ill. L. F. J. Wrinkle (E M J-Jan. 28.) 1200 w.

10049. The Occurrence of Platinum in Canada. J. F. Donald (E M J-Jan. 28.) 800 w.

*10071. Bumsted and Chandler's Mine Ventilating Fan and Engines. Ill. (Eng L-Jan. 20.) 800 w.

*10074. Coal in the Caucasus. M. Leproux. (C G-Jan. 20.) 1600 w.

*10076. American Enterprise in the Nova Scotian Coalfields (C G-Jan 20.) 800 w.

*10079. The Substitution of Steel or Iron for Timber in Mines. From paper by Isaiah Johnson (I C T-Jan. 20.) 1000 w.

10085. The Canadian Coal Syndicate (A M & I W-Jan. 27.) 650 w.

*10089. The Mining Industries of South Africa, as Shown at the Kimberley Exhibition. Bennett H. Brough (J S A-Jan. 20.) 9500 w.

10097. The Oil and Gas Regions of Ohio (A G L J-Jan. 30.) 1000 w.

10132. The New Gold Camp at Yankee Hill. C. (M I T-Jan. 26.) 950 w.

10179. The British Coal Fields. E. S. (T-Feb. 1.) 1400 w.

10237. Flameless Explosives in the Nova Scotia Coal Mines (E M J-Feb. 4.) 1000 w.

10240. Conditions of the Mining Industries in 1892.—Colorado. Thomas R. Mac Meechen (E M J-Jan. 4.) 2700 w.

10249. A Digest of the Mining Properties at the Head of the Lakes, and 1893 Shipments. D. E. W. (M Rec-Feb. 2.) 1200 w.

*10276. The Sudbury Nickel Mines (I L-Jan. 27.) 650 w.

*10291. Comparison of Mine Fans (C G-Jan. 27.) 5400 w.

*10293. Hongay and Kabas Collieries, Tonkin (C G-Jan. 27.) 1500 w.

*10296. An Occurrence of Coarse Conglomerate Above the Mammoth Anthracite Bed. B. S. Lyman (C G-Jan. 27.) 1400 w.

*10297. Electric Mine Railway at Bleiburg, in Carinthia (P Eng-Jan. 27.) 900 w.

10344. The Benefits of Electricity in Mining. John McGhil (E E N Y-Feb. 8.) 1000 w.

10349. The Coal Combination a Failure (Ir Age-Feb. 9.) 900 w.

10352. The San Juan Placer Region (M S P-Feb. 4.) 1300 w.

10390. The Condition of the Mining Industry in 1892. Montana. H. M. Beadle (E M J-Feb. 11.) 2200 w.

10391. An Old Comstock Dodge. Dan de Quille (E M J-Feb. 11.) 900 w.

10392. Practical Results from the Campbell Coal Washer. Ill. William B. Phillips (E M J-Feb. 11.) 1200 w.

10395. Smokeless Coal (M R-Feb. 10.) 450 w.

10451. The Mineral Resources of Southeast Alaska. G. W. Garside (M I T-Feb. 9.) 2500 w.

*10475. Mine Ventilators. Ill. M. Rateau (C G-Feb. 3.) 4500 w.

Serials.

9003. Diamonds in India: A Rechauffée. W. King (I E-Began Nov. 19—3 parts to date—45 cts. each).

9117. The Dalmorton Gold Field (N. S. W.) (A M S-Began Nov. 26—3 parts to date—30 cts. each).

9227. The Use of Electrical Telephonic Apparatus in Mines. Sydney F. Walker (C G-Began Dec. 16—3 parts to date—30 cts. each).

9748. Notes on the Region of Eternal Coal (C G-Began Jan. 6—Ended Jan. 27—3 parts—30 cts. each).

9954. Report on the Present Applications of Electricity to Mining in Colorado. Lewis C. Hill (M I T-Began Jan. 19—Ended Jan. 26—2 parts—15 cts. each).

9966. North West Australia Goldfields (A M S-Began Dec. 10—2 parts to date—30 cts. each).

10232. The Present Status of Natural Gas in Ohio. Edward Orton. (A M & I W-Began Feb. 3—2 parts to date—15 cts. each).

10478. The Denbighshire Coalfield. M. E. (C G-Began Feb. 3—1 part to date—30 cts).

RAILROADING.

*9658. American Railway Progress in 1892. Thomas L. Greene (E Mag-March.) 3000 w.

*9661. The Increase of Speed on Railways. Ill. Wm. Barnet Le Van (E Mag-March.) 3000 w.

9671. Railway Building in Palestine. Ill. (R A-Jan. 13.) 500 w.

9672. Australasian Railway Statistics. J. Pickering (R A-Jan. 13.) 300 w.

9674. Maintenance of a Track Section in Winter. W. E. Brown (R A-Jan. 13.) 900 w.

†9765. Railways in War Time. Editorial on papers of J. R. Bell (I E-Dec. 10.) 850 w.

9688. A Poultry Car. Ill. (R C J-Jan.) 800 w.

9689. Railroad Car Design. Archer Richards (R C J-Jan.) 1200 w.

9690. Private Cars. Ill. (R C J-Jan.) 1000 w.

9695. Views of the New York Railroad Commission (R R-Jan. 14.) 2500 w.

9696. The Locomotive "Pioneer." Ill. (R R-Jan. 14.) 700 w.

9697. Annealing Furnace at the Grant Locomotive Works. Ill. (R R-Jan. 14.) 800 w.

9698. A German Opinion of American Railways. (R R-Jan. 14.) 1450 w.

9699. An Air Brake Instruction Car. Ill. (R R–Jan. 14.) 800 w.

*9743. Winding Drums for the Pachocha Railway, Spain. Ill. (E–Jan. 6.) 400 w.

*9772. The South Staffordshire Tramways. A. Dickinson (E E L–Jan. 6.) 3000 w.

9788. The Relative Advantages of Concentric and Double Cables. M. E. Eden (E E N Y–Jan. 18.) 700 w.

*9796. Long Distance Electric Railway. Ill. (S R R–Jan.) 700 w.

*9797. Intramural Railway at the World's Fair Grounds. Ill. (S R R–Jan.) 2000 w.

*9798. Montreal's Street Railway System. Ill. (S R R–Jan.) 1500 w.

*9799. La Fayette Electrics. Ill. (S R Jan.) 1000 w.

*9800. Electricity on the Chicago City Railway. Ill. (S R R–Jan.) 1000 w.

9811. History and Advantages of the Hardie Compressed Air Locomotive for City Railroads. Robt. Hardie (Sc A S–Jan. 21.) 1800 w.

9812. Storage Battery Cars (Sc A S–Jan. 21.) 1200 w.

9813. The Coal Storage Plant at South Plainfield (Ir Age–Jan. 19.) 2000 w.

9822. Notes on Canadian Railways (E N–Jan. 19) 3800 w.

9823. Sundry Opinions on Blind Tires for Locomotives (E N–Jan. 19.) 2700 w.

9824. Corrosion of an Overhead Bridge by Locomotive Gases, Rochester, N. Y. Ill. (E N–Jan. 19.) 1000 w.

9826. Some Advantages of a Double-Decked Rapid Transit Tunnel Under Broadway. Ill. J. W. Reno (E N–Jan. 19.) 900 w.

9845. The Proposed Standard Code for Interlocking and Block Signaling. Arthur H. Johnson (R G–Jan. 20.) 1600 w.

9846. Clearance-Measuring Car, Pennsylvania Railroad. Ill. (R G–Jan. 20.) 500 w.

9847. A System of Transfer Accounts for Railroad Supplies (R G–Jan. 20.) 500 w.

9848. The Substitution of Steel for Iron in the Construction of Rolling Stock. Discussion of Mr. Richards' Paper, with Editorial (R G–Jan. 20.) 3000 w.

9849. Maximum Average Speed and Capacity of Rapid Transit Trains (R G–Jan. 20.) 2500 w.

9860. The Tension in Ferranti Cables. Ill. Dr. Belan Eschenburg (E W–Jan. 21.) 1200 w.

9873. The Railroad Survey of the Colorado River (E M J–Jan. 21.) 900 w.

*9880. Blasting Operations on Railways. Ill. (E–Jan. 13.) 1800 w.

*9881. The New Railway Rates and British Trade. Editorial (E–Jan. 13.) 1600 w.

*9882. Transition Curves. Ill. (E–Jan. 13.) 1800 w.

*9891. Automatic Electric Railway Signaling. Ill. (R W–Jan.) 500 w.

*9892. High Speed on an American Railway (R W–Jan.) 700 w.

*9893. Grand Trunk Railway of Canada. Ill. (R W–Jan.) 2000 w.

9895. Rates of Pay on Railroads (R A–Jan. 20.) 300 w.

9915. Adjustment of Wheat Rates in the Northwest, with Editorial (R R–Jan. 21.) 7000 w.

9916. Coaling Stations. Editorial (R R–Jan. 21.) 800 w.

9917. Why Pooling Should Be Legalized (R R–Jan. 21.) 2500 w.

9929. Some Considerations on Electric Railways in Winter. Ill. (S R G–Jan. 23.) 800 w.

10010. The Right of Way of Street Railroads. LL. B. (S R N–Jan. 28.) 1000 w.

10013. American Locomotives on New Zealand Railways. Ill. Charles Rous Marten (E N–Jan. 26.) 3000 w.

10022. Elevated Railroad Superstructure in Philadelphia. Ill. (E R–Jan. 28.) 750 w.

10029. Rapid Transit in New York. Map (R G–Jan. 27.) 1800 w.

10030. A Lesson in Trestle Construction. Ill. (R G–Jan. 27.) 750 w.

10031. Lubrication. Discussion of Mr. Barr's paper (R G–Jan. 27.) 5800 w.

10032. The Baltimore and Ohio's Historical Exhibit at the World's Fair (R G–Jan. 27.) 1800 w.

10033. The Fort Street Union Depot, Detroit. Ill. (R G–Jan. 27.) 800 w.

10035. Freight Car Truck Frames.—Queries of the Committee of the Master Car Builders' Association (R G–Jan. 27.) 1100 w.

†10036. A Steam Tramway Constructed by Private Enterprise (I E–Dec. 24.) 1600 w.

10051. More Railroad Regulation in Texas (M R–Jan. 27.) 500 w.

*10070. The Saxby and Bourne Railway. Ill. (Eng L–Jan. 20.) 1800 w.

10091. A Graphic Time Table. Ill. (R A–Jan. 27.) 600 w.

10092. Why the Railroads Should Be Treated as Composing One American Railroad System. Joseph Nimmo, Jr. (R A–Jan. 27.) 6500 w.

10093. A Novelty in Train Designing. Ill. (R A–Jan. 27.) 300 w.

10099. Wheat Rates in the Northwest, with Editorial (R R–Jan. 28.) 1700 w.

10100. An Extensive Block Signal System. Ill. (R R–Jan. 28.) 2200 w.

10101. Furniture Car.—Chicago, Burlington and Quincy Railroad. Ill. (R R–Jan. 28.) 1300 w.

10102. Railway Progress in Japan (R R–Jan. 28.) 1000 w.

10103. The Rights of Railway Employés (R R–Jan. 28.) 1200 w.

10104. Why "Pooling" Should Be Permitted. Letter of A. F. Walker (R R–Jan. 28.) 1500 w.

10105. Automatic Electric Signal Clocks for Starting Railway Trains. Ill. (R R–Jan. 28.) 1200 w.

10106. Should Pooling Be Legalized? Replies of Simon Sterne, M. B. Fleming, and D. B. Smith (R R–Jan. 28.) 2500 w.

10107. The Los Angeles Cable Snarl. Ill. (S R G–Jan. 30.) 650 w.

10108. The Cost of European Street Railway Traction (S R G–Jan. 30.) 1300 w.

*10138. The Finest Two-Cylinder Compound in Europe. Ill. (L E–Feb.) 400 w.

*10140. On Car Wheels (L E–Feb.) 1200 w.

10150. The Electric vs. the Steam Locomotive. H. S. A. C. (E E N Y–Feb. 1.) 300 w.

10152. The Power Station of the New Haven and West Haven Street Railway, New Haven, Conn. Ill. A. C. Shaw (E E N Y–Feb. 1.) 3300 w.

10153. The Electric Car to Washington's Home. Ill. (E E N Y–Feb. 1.) 900 w.

†10158. The Wilmington, Del., City Railway. Ill. (S R J–Feb.) 3000 w.

†10159. Inclined Plane at Marseilles. Ill. (S R J–Feb.) 300 w.

10190. Computing the Contents of Railroad and Other Cuttings and Embankments. Ill. (C–Feb.) 900 w.

10196. Track for High Speeds (E N–Feb. 2.) 2000 w.

10199. The Delano Rail Joint; Chicago, Burlington and Quincy Railroad. Ill. (E N–Feb. 2.) 1700 w.

10215. Massachusetts Railroad Commissioners' Report (R G–Feb. 3.) 2000 w.

10216. Couplers and Deadwoods for Freight Cars.—Discussion and Editorial (R G–Feb. 3.) 1700 w.

10217. The Railroads of Russia (R G–Feb. 3.) 1900 w.

*10219. Locomotive and Tender Connections. Ill. (R A E J–Feb.) 1700 w.

*10228. The Great Railway Systems of the United States.—The Atchison, Topeka and Santa Fé. Ill. C. S. Gleed (Cos–Feb.) 7000 w.

10243. The Necessity for Co-operation Among Railways. Aldace F. Walker (R A–Feb. 3.) 2700 w.

*10246. The Philadelphia and Reading Railroad Company. Descriptive of the Country Through Which the Lines Pass. Ill. (R'y N–Jan.) 11500 w.

10251. Facts About Palace Cars (Eng–Feb. 4.) 600 w.

*10308. Railway Entrances to San Francisco. Ill. R. E. Bush (I S F–Feb.) 3000 w.

†10319. The Increasing Cost of Railway Tie Renewals, with Discussion. Benjamin Reece (T C E–Dec.) 7000 w.

†10321. Discussion on Tests of Power Required to Drive Electric Street Cars. C. B. Brush, C. E. Emery, A. F. Sears, and L. B. Bonnett (T C E–Dec.) 1400 w.

10330. The Pecos River Bridge. Ill. (Sc A–Feb. 11.) 650 w.

10347. A New Design for Railroad Trains (Ir Age–Feb. 9.) 1000 w.

10360. The Heilmann Electric Locomotive. Ill. (W E–Feb. 11.) 1800 w.

10361. Badt's Multiphase Railway and Lighting Systems. Ill. (W E–Feb. 11.) 800 w.

10362. Great Western Manufacturing Company, Ill. (W E–Feb. 11.) 3000 w.

10369. A Novel Flexible Wheel-base Locomotive. Ill. (E N–Feb. 9.) 400 w.

10370. Atmospheric Train Resistance. Editorial (E N–Feb. 9.) 2600 w.

10371. Fuel Consumption on Electric and Steam Railways (E N–Feb. 9.) 2000 w.

10372. Brooklyn Bridge Terminal Station (E N–Feb. 9.) 700 w.

10377. New Saloon Carriages on the London and Southwestern Railway. L. (R G–Feb. 10.) 800 w.

10379. Compressed Air Shop Crane. Ill. (R G–Feb. 10.) 400 w.

10380. Metal Ties and Track Maintenance (R G–Feb. 10.) 1100 w.

10383. Service Strength of M. C. B. Couplers. Editorial (R G–Feb. 10.) 800 w.

10385. The Extension of the New Haven Road to Boston (R G–Feb. 10.) 800 w.

*10413. The Development of Rapid Transit. T. Phillips White (G G M–Jan.-Feb.) 1000 w.

10416. Suggestions for Co-operation Among Railways. A General Manager (R A–Feb. 10.) 1600 w.

10417. "A Vicious Bill"—The Proposed Amendment to the Interstate Commerce Act. Joseph Nimmo, Jr. (R A–Feb. 10.) 1200 w.

10418. Canadian Railway Competition by Bonded Cars (R A–Feb. 10.) 1250 w.

10419. A Railway Accounting Office. J. Shirley Eaton (R A–Feb. 10.) 1600 w.

10422. Improvements in Hand Cars. Jerry Sullivan (R R–Feb. 4.) 800 w.

10424. Railway Signaling as Applied to Large Installations. Ill. John P. O'Donnell (R R–Feb. 4.) 4300 w.

10440. The Reduction of Expenses in the Operation of Electric Street Railways. G. D. Shepardson (S R G–Feb. 13.) 550 w.

10441. Government Railways in a Democratic State. W. M. Acworth (R R–Feb. 11.) 2000 w.

10442. Robbing Railroads Fair Play (R R–Feb. 11.) 700 w.

10443. Two-cent Railroad Fare. Henry Apthorp (R R–Feb. 11.) 3500 w.

10445. Live Stock Contracts, with Editorial (R R–Feb. 11.) 1500 w.

10447. Should Pooling Be Legalized? Letters from Mr. Midgeley and E. P. Vining (R R–Feb. 11.) 3300 w.

*10458. Deep Tunnel Railways in London. Editorial (E–Feb. 3.) 2600 w.

10467. Rights of Electric Cars (E R N Y–Feb. 18.) 300 w.

*10476. Railway Charges and Midland Industries (G C–Feb. 3.) 1500 w.

*10480. American Engines in New Zealand. Ill. C. Rous Martin (Eng L-Feb. 3.) 2000 w.

*10482. Heating Surface in Locomotive Engines. Editorial (Eng L-Feb. 3.) 1800 w.

*10498. Railroad Requirements in Rubber Goods. I. A. Sherman (I R W-Feb. 15.) 750 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A-Began Oct.—4 parts to date—30 cts each).

9174. New York and Harlem Railroad—The First Street Railroad in the World—Particulars of Its Early History. Ill. W. S. Carman (S R J-Began Jan.—2 parts to date—45 cts. each).

9254. Railway Management. Horace Cope (R R-Began Dec. 31—3 parts to date—15 cts. each).

9492. The Resistance of Railway Curves. G. Pennington (M W-Began Dec. 30—Ended Jan. 27—2 parts—30 cts. each).

9739. New Railways in Spain. Ill. (I L-Began Jan. 6—1 part to date—30 cts).

9753. Euphrates Valley Railway Route in India (I Eng-Began Dec. 17—1 part to date—30 cts).

9820. Philadelphia and Reading Terminal Railroad Station, Philadelphia, Pa. Ill. (E N-Began Jan. 19—2 parts to date—15 cts. each).

10011. The City Electric Street Railway Power Station of Little Rock, Ark., and Its Record. Ill. B. J. Arnold (E N-Began Jan. 26—Ended Feb. 9—2 parts—15 cts. each).

10111. The Liverpool Overhead Railway. Ill. (E E L-Began Jan. 20—2 parts to date—30 cts. each).

10378. The Evolution of the Railroad Turntable. Ill. (R G-Began Feb. 10—1 part to date—15 cts.).

10446. Permanent Way for Viaducts. Ill. Herbert Tatham Procter (R R-Began Feb. 11—1 part to date—15 cts).

SANITARY ENGINEERING.

*9737. Sanitary Engineering. Editorial (Eng L-Jan. 6.) 1500 w.

†9754. A Boom in Sanitation (I Eng-Dec. 17.) 900 w.

9830. Extension of the Outfall Sewer Under the Harbor at New London, Conn. Ill. Geo. K. Crandall (E N-Jan. 19.) 1000 w.

*10267. The Fine Arts in Relation to the Sanitary Condition of Our Great Cities. Wyke Bayliss (J S A-Jan. 27.) 7000 w.

*10314. Instructions to Sewer Inspectors. Ill. Arthur Lagron (P-Feb.) 700 w.

†10320. The Shone Hydro-Pneumatic System of Sewerage. Ill. Urban H. Broughton (T C E-Dec.) 7000 w.

10401. Bursting Pipes by Frost. Ill. Leicester Allen (Met W-Feb. 11.) 3600 w.

10402. The Heating and Ventilating of Large Buildings. Ill. Alfred R. Wolff (Met W-Feb. 11.) 4300 w.

10409. Heating and Ventilation of the Worcester, Mass., High School. Ill. (E R-Feb. 11.) 1000 w.

*10452. The Purification of the Air Supply to Public Buildings and Dwellings. William Key (J S A-Feb. 3.) 10000 w.

*10488. The Craft of Plumbing. William Garnett (Pl D-Feb. 1.) 4000 w.

*10497. Hygienic Appliances at the Lyceum Theater. Editorial (Inv-Feb. 4.) 1300 w.

Serials.

5358. Sewage Purification in America (E N-Began July 14—20 parts to date—15 cts. each).

8127. Ventilation and Heating. John S. Billings (E R-Began Nov. 19—3 parts to date—15 cts. each).

8700. Drainage Blunders. Ill. Albert L. Webster (E R-Began Dec. 10—4 parts to date—15 cts. each).

9693. Sanitary Legislation (S R-Began Jan. 1—2 parts to date—30 cts. each).

9725. The Chemical Bacteriology of Sewage; Its Hygienic Aspect. W. E. Adeney (Pl D-Began Jan. 2—2 parts to date—30 cts. each.

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—1 part to date—30 cts.)

STEAM ENGINEERING.

*9709. Feeding the Boiler (A J R A-Jan.) 800 w.

9714. Four Boilers Let Go Simultaneously and Nobody Can Tell Why. Explosion at Newport, Ky. Ill. (S V-Jan. 15.) 800 w.

9715. Was This Shaft Originally Defective, or Did It Become So Because of Interior Strains and Crystalization? Wamsutta Mills. Ill. (S V-Jan. 15.) 1000 w.

*9742. Boiler Tube Fastenings. Ill. (E-Jan. 6.) 2500 w.

9827. Bursting Tests of Copper Steam Pipes (E N-Jan. 19.) 2400 w.

9865. Belleville Boilers. Ill. Miers Coryell (Eng-Jan. 21.) 3000 w.

*9879. Tests of Longitudinal Elasticity of Boiler Flues. Abstract of paper by Mr. Knoudt. Ill. (M W-Jan. 13.) 3000 w.

9888. Designing a Steam Heating System (B J C-Jan. 21.) 2200 w.

*9922. The Mystery of Steam. William Donaldson (Eng L-Jan. 13.) 2800 w.

9962. The Development of High Speed Automatic Cut-off Engines. Ill. (E R N Y-Jan. 28.) 1600 w.

9979. The Peck-Wheeler System of High Temperature (Combined Live and Exhaust Steam) Feed-Water Heating. Ill. (A M-Jan. 26.) 1600 w.

9981. Journal Bearing. High-speed Engines. Samuel T. Williams (A M-Jan. 26.) 1700 w.

10019. Automatic Safety Stop for Corliss Engines. Ill. (W E-Jan. 28) 500 w.

10020. Engineers' Examination and License

Law of Tennessee, with Editorial (S E–Jan. 21.) 1900 w.

10026. Break of Gears and Fly-Wheel at Woonsocket, R. I. Ill. (E R–Jan. 28.) 700 w.

10067. Condenser Tubes (B J C–Jan. 28.) 600 w.

10094. Smoke Prevention Made Easy. Ill. (R A–Jan. 27.) 300 w.

*10124. Steam Blowers for Promoting Combustion. Ill. (E R L–Jan. 20.) 600 w.

*10136. The Smoke Nuisance in Pittsburg (G W–Jan. 21.) 3000 w.

10206. A New Calorimeter. Ill. R. C. Carpenter (P S–Feb.) 1800 w.

10207. Indicator Rigging. Ill. P. M. (P S–Feb.) 1100 w.

10208. Finding the Horse-Power of a Boiler from the Gage-Glass. Ill. (P S–Feb.) 600 w.

10229. Size of Steam Pipes. The Rules for Finding Their Proper Dimensions (B J C–Feb. 4.) 1500 w.

10230. Liquid Fuel for Making Steam (B J C–Feb. 4.) 1800 w.

†10253. The Priestman Engine as Manufactured in America. Ill. Coleman Sellers (J F I–Feb.) 7000 w.

10262. Some Points in Metallic Packing. Metallic (R M M–Feb.) 800 w.

10310. The Steam Equipment of Modern Central Stations. Alfred A. Hunting (E N Y–Feb. 8.) 3000 w.

10355. The Injector. D. H. Welch (S E–Feb. 4.) 1250 w.

10373. Tests of the Blake High-Duty Pumping Engine (E N–Feb. 9.) 900 w.

Serials.

8837. Steam vs. Hot Water for Greenhouse Heating. Ill. L. R. Taft (D E–Began Dec. 15—2 parts to date—15 cts. each).

8919. Combustion of Coal and Prevention of Smoke (P Eng–Began Dec. 7—4 parts to date—30 cts. each).

9427. Notes on the Steam Injector. Strickland L. Kneass (E M–Began Jan.—2 parts to date—30 cts. each).

9817. The Injector. Ill. I. B. Rich (S M–Began Jan. 15—1 part to date—15 cts).

9980. The Natural Governing of Direct-Acting Steam Pumps. Ill. David Guelbaum (A M–Began Jan. 26—2 parts to date—15 cts. each).

10086. Steam Engine Friction. W. H. Wakeman (M G–Began Jan. 28—Ended Feb. 4—2 parts—15 cts. each).

TELEPHONY AND TELEGRAPHY.

*9663. The Practical Value of Long-Distance Telephony. Herbert Laws Webb (E Mag–March.) 3000 w.

9673. A New Telephone System (R A–Jan. 13.) 400 w.

*9759. Self-Induction in Telegraphy and Telephony (El–Jan. 6.) 1500 w.

*9760. The Use of a Shunt with High Self-Induction in Cable Telegraphy. Ill. (El–Jan. 6.) 3500 w.

9806. Interference of Electrical Waves in a Metallic Circuit Illustrated by the Telephone. M. R. Colson (E R N Y–Jan. 21.) 1000 w.

*9938. The Post-Office Telephone. Ill. (El–Jan. 13.) 1600 w.

9965. Mr. Lyon's Lecture on Long Distance Telephony (E R N Y–Jan. 28.) 500 w.

10169. The Blake Transmitter.—Expiration of Patents. Ill. (E A–Feb. 4.) 1200 w.

*10415. Electrical Signalling by Means of Currents without Wires. Sydney F. Walker (E G–Feb.) 2500 w.

10466. Boston and Chicago United. Ill. (E R N Y–Feb. 18.) 1200 w.

10469. Field's Improvement in Telephony. Ill. (E R N Y–Feb. 18.) 400 w.

*10485. The Telephone in the United Kingdom (E P–Feb. 1.) 2000 w.

*10492. The Simplification of the Quadruplex, and the Importance of its Achievement. Ill. D. H. Keeley (El–Feb. 3.) 4000 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El–Began Sept. 2—9 parts to date—30 cts. each).

10285. Inaugural Address of W. H. Preece.—Telegraphy (E E L–Began Jan. 27—1 part to date—30 cts).

10470. The Theory of Submarine Cable Laying. Ill. G. W. Littlehales (E E N Y–Began Feb. 15—1 part to date—15 cts).

MISCELLANEOUS.

*9655. America's Need of the Nicaragua Maritime Canal. Warner Miller (E Mag–March.) 3000 w.

*9660. The Glass-Making Industry in America. Ill. Robert M. Atwater (E Mag–March.) 3000 w.

*9662. Is the Climate Changing? Henry Allen Hazen (E Mag–March.) 3000 w.

*9664. The Annexation of Hawaii. T. Graham Gribble (E Mag–March) 3000 w.

*9728. Engineering Prospects in the Australasian Colonies (Eng L–Jan. 6.) 1200 w.

*9758. American and British Workmen and Machinery.—Bounce vs. Progress. An Englishman (M W–Jan. 6.) 5000 w.

*9774. Scientific and Material Advancement of the Past year (I–Jan. 6.) 9600 w.

9778. Artificial Rubber and the Peculiar Manner of Its First Production (M S R–Jan. 12.) 700 w.

†9852. The Present Position of Canada: A Reply. Arnold Haultain (W R–Jan.) 5000 w.

9894. The Transportation System of the United States. Henry C. Adams (R A–Jan. 20.) 4200 w.

9896. Harvesting India Rubber (M G–Jan. 21.) 1000 w.

9940. Burning Pulverized Coal (M N–Jan. 15.) 500 w.

†9948. Imminent Danger from the Silver Purchase Act. Geo. Fred. Williams (F–Feb.) 3000 w.

*9991. Then and Now. Alexander H. Smith (S–Jan.) 1800 w.

*9993. Dynamite and Its Use. George H. Harris (S–Jan.) 1800 w.

10025. Justice Pinney's Decision on the Letting of Municipal Contracts (E R–Jan. 28.) 2000 w.

10041. A Frenchman on the World's Fair and America (A A–Jan. 28.) 4000 w.

*10122. What Is a Consulting Engineer? Editorial (E R L–Jan. 20.) 1800 w.

†10145. Why Immigration Should Not Be Suspended. Henry C. Hansbrough (N A R–Feb.) 3000 w.

10187. Municipal Inconsistency on the Smoke Problem (Ir Age–Feb. 2.) 800 w.

*10188. The French Projects in Northern Syria. Ill. (E–Jan. 20.) 4000 w.

10201. Degrees at Scientific Schools. Editorial (E N–Feb. 2.) 1200 w.

10205. Radius of Gyration of Hollow, Round, and Square Columns. B. F. La Rue (E N–Feb. 2.) 900 w.

10221. Education and Energy Make a Sure Road to Success. F. G. Heeger (S E–Jan. 28.) 3500 w.

*10299. The Liquefaction of Air. Ill. Abstract of Lecture by James Dewar (Eng L–Jan. 27.) 1800 w.

*10301. Non-Poisonous White Lead. Editorial (Inv–Jan. 28.) 1700 w.

10334. President Gathing's Address at the Annual Meeting of the American Association of Inventors and Manufacturers (I Age–Feb.) 2500 w.

10346. Possibilities in Utilizing the Power of the Wind. G. D. Hiscox (Ir Age–Feb. 9.) 3000 w.

10359. The North Greenland Expedition of 1891–92. Ill. R. E. Peary (B G S–Dec. 31.) 6500 w. (*Price of this article: $1 or 7 coupons.*)

10376. The Relation of a Foreman to His Men (F D–Nov.) 1200 w.

10389. Licensing Engineers in Massachusetts (B J C–Feb. 11.) 2000 w.

*10405. The Engineer and His Work. B. F. Isherwood (N W–Jan.) 1650 w.

*10412. South American Water-Ways. T. P. Porter (G G M–Jan-Feb.) 1400 w.

*10495. Electric Balloon Signalling. Eric Stuart Bruce (E R L–Feb. 3.) 1400 w.

Serials.

2845. The Engineering Schools of the United States (E N–Began March 19—Ended Feb. 11—38 parts—15 cts. each).

8931. The Value of Inventions to Civilization (Inv–Began Dec. 10—Ended Jan. 14—5 parts—30 cts. each).

9401. World's Columbian Exposition (E N–Began Jan. 5—2 parts to date—15 cts. each).

9485. The Errors of Experts. Joseph Williams (Inv–Began Dec. 31—Ended Jan. 14—3 parts—30 cts. each).

9519. Municipal Equipment and Engineering of Paris. Jas. W. Howard (P–Began Jan.—2 parts to date—30 cts. each).

9678. Great Accidents and Contributory Causes. A. Ewbank (I E–Began Dec. 10—2 parts to date—45 cts. each).

9745. American Industries and British Commerce (E–Began Jan. 6—4 parts to date—30 cts. each).

9851. The Glass Industry. C. Hanford Henderson (P S M–Began Feb.—1 part to date—45 cts).

10490. The Diffusion of Light. W. E. Sumpner. (El–Began Feb. 3—1 part to date—30 cts).

NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Bates, W. W.=American Marine: The shipping question in history and politics. Boston: Houghton. [8vo, cloth, $4.]

Berg, Walter G.=Buildings and Structures of American Railroads. A reference book for railroad managers, superintendents, master-mechanics, architects, and students. New York: Wiley. [4to, cloth, 534 p., $7.50.]

Birkmire, W. H.=Compound Riveted Girders as Applied in the Construction of Buildings; with Practical Illustrations and Tables. New York: Wiley. [8vo, cloth, 128 p., $2.]

Bonney, G. E.=Electrical Experiments. A Manual of Instructive Amusement. London: Whittaker & Co. [16mo, cloth, 252 p., 75 cts.]

Bottone, S. R.=How to Manage the Dynamo. A handbook for ship engineers, electric light engineers, and electro-platers. New York: Macmillan. [8vo, cloth, 63 p., 60 cts.]

Bovey, H. T.=Theory of Structures and Strength of Materials. New York: Wiley. [8vo, cloth, 832 p., $7.50.]

Chapuy, P.=Cours des Machines. Lille: Libr. Quarré. [4to, 430 p., 14 *fr.*]

Conoyer, E.=Gothic Architecture. Edited by Walter Armstrong. New York: Macmillan. [12mo, cloth, 404 p., $2.]

Dolbeer, Alonzo.=When Should a Locomotive be Destroyed? New York: Railroad Club. [16mo, paper, 17 p.]

Engelard.=L'Eclairage Electrique. Manuel pratique des ouvriers électriciens et des amateurs pour le choix des appareils, le montage, la con-

duite, et l'entretien des installations. Paris: Libr. Marie. [18mo, paper, 204 p., 2 *fr.*]

Field, H. M.=The Story of the Atlantic Telegraph. New York: Scribner. [8vo, cloth, 423 p., $1.50.]

Foote, Allen Ripley, and Everett, C. E.=Economic Legislation of all the States: the law of incorporated companies operating under municipal franchises, such as illuminating gas companies, fuel gas companies, electric central-station companies, telephone companies, street-railway companies, water companies, etc., preceded by a suggestive discussion of the economic principles involved in the operation, control, and service of such companies. In 2 vols. Vol. 1 now ready. Cincinnati: Clarke. [8vo, sheep, 1367 p., $12.00 for complete work.]

Frith, H.=The Romance of Engineering: the stories of the highway, the waterway, the railway, and the subway. New York: Ward, Lock, Bowden & Co. [12mo, cloth, 364 p., $1.25.]

Geometrical Draughtsman (The). A series of practical diagrams and designs applicable to the work of the architect and builder, the engineer and machinist, the artisan and general draughtsman, in designing the various structures useful in the industrial arts; with a practical paper introductory to the work of industrial drawing and designing, by various authors and draughtsmen; Ed. by the editor of "The Industrial Self-Instructor." New York; Ward, Lock, Bowden & Co. [8vo, cloth, 150 p., $2.]

Grimshaw, R.=Tips to Inventors. Telling what inventions are needed, and how to perfect and develop new ideas in any lines. New York: Practical Publishing Co. [16mo, cloth, 84 p., $1.]

Grimshaw, Robert.=Engine-Room Chat. New York: Practical Pub. Co. [16mo, cloth, 144 p., $1.]

Hamerton, Philip Gilbert.=Drawing and Engraving: a brief exposition of technical principles and practice. New York: Macmillan. [4to, cloth, 194 p., $7.]

Heaviside, Oliver.=Electrical Papers. New York: Macmillan. [8vo, cloth, 2 vols., $10.]

Hofman, H. O.=The Metallurgy of Lead and the Desilverization of Base Bullion. New York: Scientific Pub. Co. [8 vo, cloth, 415 p., $2.]

Holman, Silas W.=Discussion of the Precision of Measurements. New York: Wiley. [8vo, cloth, 183 p., $2.]

Jamieson, Andrew.=Applied Mechanics. Specially arranged for elementary engineering students. Philadelphia: J. B. Lippincott Co., [12 mo, cloth, $1.25.]

Jones, George W.=Logarithmic Tables: Eighteen tables for use in the class-room and laboratory. Ithaca: G. W. Jones. [8vo, cloth, 160 p., $1.]

Keasbey, E. Quinton.=The Law of Electric Wires in Streets and Highways. Chicago: Callaghan & Co. [8vo, sheep, 201 p., $3.50.]

Kent, Walter G.=The Water Meter: Its Difficulties, Types, and Applications. A manual of reference and fact in connection with the supply of water by meter. New York: Spon. [8vo, cloth, 122 p., $1.50.]

Laffaille.=Théorie sur la Recherche du Pas des Vis, Résolvant Tous les Cas Possibles et Difficultueux, à l'Usage des Ouvriers Mécaniciens. Montrouge: Laffaille. [32mo, paper, 46 p., 1 *fr.*]

Lefèvre, J.=Le Chauffage et les Applications de la Chaleur dans l'Industrie et l'Economie Domestique. Paris: J. B. Ballière et fils. [18mo, paper, 360 p.]

Maycock, W. Perren.=Electric Lighting and Power Distribution. An elementary manual for students preparing for the ordinary grade examnation of the city and guilds of London Institute. Part 1. New York: Macmillan. [12mo, paper, 97 p., 75c.]

Minchin, G. M.=Hydrostatics and Elementary Hydrokinetics. New York: Macmillan. [12 mo, cloth, 435 p., $2.60.]

Müller, E. R.=Die Elektrischen Maschinen: with Notes for American Students by Oswald Seidensticker. New York: Holt. [8vo, paper, 30 cents.]

Ockerson, J. A. and Stewart, C. W.=The Mississippi River from St. Louis to the Sea. Maps prepared from official reports of recent United States surveys. St. Louis. [Paper, 41 p.]

Pelletier, M.=La Protection des Dessins et Modèlles de Fabrique dans la Législation Ancienne, Actuelle, et Future. Paris: Libr. Chaix. [8vo, paper, 24 p.]

Riche and Roume.=Rapport sur la Production, l'Industrie, et la Commerce des Huiles Minérales aux Etats-Unis d'Amérique. Paris: Impr. Nationale. [4to, paper, 107 p.]

Sarrau, E.=Introduction à la Théorie des Explosifs. Paris: Gauthier-Villars et fils. [8vo, paper, 119 p., 2 *fr.* 75c.]

Sykes, F. J.=Public Health Problems. New York: Scribner. [12mo, cloth, 379 p., $1.25.]

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"W. & S" Hydraulic Machinery Works.=Price List of Improved Hydraulic Jacks. New York. [Paper, 36 p.]

COMMENT & CRITICISM.

The Mississippi Problem Not Solved.

IN the article entitled "Geology and the Mississippi Problem," in the January number of this Magazine, appears the statement that the one scientific and sensible treatment for the Mississippi river would be to give it a channel as nearly straight as possible from Cairo to the Gulf.

This condition if once established would, during the short time that it remained, greatly increase the capacity of the upper river to discharge its flood waters, relieving that part of the valley at the expense of the lower part.

As to navigation demanding this kind of improvement, it is a question whether or not navigators would want a condition of affairs under which much of their shipping would be useless. For, if the velocity of the current would then be nearly doubled, as stated, most of their boats could not stem the current profitably.

The statement that the river would do most of the straightening itself, as soon as the needed cut-offs were made, is a direct contradiction of the established rule of rivers flowing through an alluvial soil, and especially of the Mississippi. There is no evidence to prove that, after the proposed treatment, the Mississippi would suddenly change from a stream that is constantly making bends, to one that would straighten its course. To prove that the river is constantly making bends we need only point to its present course, and to the many crescent-shaped lakes in its vicinity. When a cut-off is made, the increased current causes increased caving, which soon adjusts the river to about its former conditions. It could be trained to follow a direct channel only by a permanent protection of its banks almost continuously from Cairo to the mouth.

The immediate effect of straightening the channel would be to raise materially the flood height in the lower basin, causing the destruction of a vast amount of property, and very likely the total annihilation of New Orleans and other cities situated therein.

Grant that straightening the channel is the proper treatment for the present; still it is no solution of the problem, but merely a postponement at the best. If the river were to extend into the Gulf, its fall would be decreased, also the velocity of its current, which would cause an increase in the disposition of sediment and by the author's argument a building up of the bed of the river; this would gradually extend up-stream until we should have conditions about the same as now exist.

CHARLES H. MILLER.

Greenville, Miss., February 10, 1893.

It Goes Everywhere.

I HAVE recently returned from a trip to the West Indies, during which I rode in a mule-wagon around the entire island of Jamaica. At Mandeville, far in the interior, 6000 feet above sea-level, and about as far away from everybody and everything as you can imagine, I found an Englishman who is a reader of THE ENGINEERING MAGAZINE, and one of your greatest admirers. I feel that this information will be welcome to you, as it was certainly a surprise and gratification to me as an American. F. S. STONEALL.

New York, February 11, 1893.

Erratum.

THE total length of the Cape Colony railroads, incorrectly given on page 704 of the February number of this Magazine at 8000 miles, is a little over 2000 miles.

"The greatest step that has been take[illegible] recent years towards systematizing work" for the engineer, architect, electrician, business man, and student.—See Page 931.

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MARCH, 1893.

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Hon. WARNER MILLER, President Canal Construction Co.

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GEORGE HILL, A New York Architect.

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HENRY A. GRIFFIN, Secretary Cleveland Board of Control.
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Prof. H. A. HAZEN, United States Weather Bureau.

The Increase of Speed on Railways.
WILLIAM BARNET LE VAN, M. Am. Soc. M. E. Illus.

Locations for the Pig-Iron Industry.
JOHN BIRKINBINE, President Am. Inst. Mining Engineers.

American Railway Progress in 1892.
THOMAS L. GREENE, New York "Evening Post" Staff.

Value of Long-Distance Telephony.
HERBERT LAWS WEBB, Electrical Engineer.

The Glass-Making Industry in America
R. M. ATWATER, A Former Manufacturer. Illus.

American Annexation of Hawaii.
T. GRAHAM GRIBBLE, C. E., Late of Honolulu.

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Introduction to Authors, Page 4.

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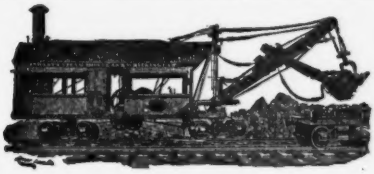

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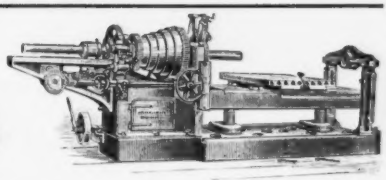

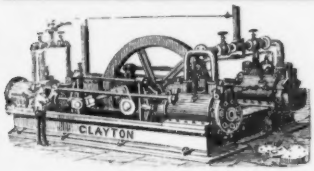

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A WORD OF INTRODUCTION.

WARNER MILLER, who writes on "*America's Need of the Nicaragua Maritime Canal*," is the president of the Nicaragua Canal Construction Company. He was born in Oswego county, N. Y., August 12, 1838; graduated from Union College in 1860; volunteered in the Union army and was taken prisoner at the battle of Winchester; engaged in paper-manufacture and farming; twice a member of the New York Assembly (1874-75); elected to Congress in 1876 and 1878, and to the United States Senate in 1881.

GEORGE HILL (*The Relation Between the Engineer and the Architect*)=Member American Society of Mechanical Engineers; Associate Member American Institute of Electrical Engineers; a consulting engineer who has had several years of experience in the capacity of engineer and manager of one of the large architectural offices in New York city, and twelve years of very wide general engineering experience. His opinions are based largely on personal experience, extending over a sufficient time to permit them to thoroughly crystalize, and should aid in the solution of this vexed question.

JOHN BIRKINBINE (*Locations for the Pig-Iron Industry*)=President of the American Institute of Mining Engineers, president of the Engineers' Club of Philadelphia, member of the American Society of Mechanical Engineers, and actively connected with several other engineering societies. His professional work has been confined to hydraulics and iron metallurgy. He has contributed many articles to the technical press and the Transactions of the Institute of Mining Engineers, besides lecturing before the Franklin Institute and editing for nine years the *Journal* of the United States Association of Charcoal-Iron Workers.

HERBERT LAWS WEBB (*The Practical Value of Long-Distance Telephony*)=Began his electrical career as an electrician on board a cable-ship and served for eight years on various submarine cable expeditions in the Mediterranean, Red Sea, Atlantic, and Pacific. He was for some years assistant electrician of the Metropolitan Telephone Co. (New York) and resigned to take the editorship of *Electricity*. The articles on telephony and other electrical subjects contributed by Mr. Webb to leading technical journals would fill a large volume. He is the author of a "Practical Guide to the Testing of Insulated Wires and Cables" and joint author of "Electricity in Daily Life," and has just completed a book on a branch of electrical engineering that has been left almost untouched by other writers. Mr. Webb is a member of the Council of the American Institute of Electrical Engineers and of the Advisory Committee of the International Electrical Congress to be held at Chicago in connection with the World's Fair. He is a member of the Institution of Electrical Engineers of Great Britain.

THOMAS L. GREENE (*American Railway Progress in 1892*)=Was engaged in practical railroading for fifteen years, until 1885, since which time he has been a writer upon railroad and kindred interests, and engaged in investigations as to the intrinsic values of railroad properties. He is on the editorial staff of the *Evening Post*, of New York.

WILLIAM BARNETT LE VAN (*Increasing Speed on Railway Trains*)=Member of the Franklin Institute of Pennsylvania; Member of the American Society of Civil Engineers; in practice as Consulting Engineer, making a specialty of steam-boilers; has written "High Railway Speeds," "Ninety Miles in Sixty Minutes," "The Weakening of Steam Boilers by Cutting Holes in the Shell for Domes and Necks," "Is Engineering on the Decline?" "Transportation Facilities of the Past and Present," "Modern Railroad Facilities," "Economical Steam Power," "The Steam Engine Indicator," etc.

RICHARD M. ATWATER (*The Glass-Making Industry in America*)=Born at Providence, R. I., 1844; graduated from Brown University, 1865; member of the Corporation of Brown University since 1879; member of the American Chemical Society; twenty-five years in the glass-manufacture in New Jersey; spent two years in Europe studying the glass-making industry; head of the firm of R. M. Atwater & Sons, glass engineers at Pittsburgh; has contributed many papers on glass-manufacture to American and English technical journals.

HENRY A. GRIFFIN (*Ship-Building on the Great Lakes*)=Secretary of the Board of Control of the city of Cleveland, Ohio; is a journalist by professon, having sustained an important relation to the press of Cleveland, Detroit, and Buffalo.

T. GRAHAM GRIBBLE (*American Annexation of Hawaii*)=A civil engineer of wide experience in Great Britain and the United States, who resided for some years in Hawaii as Chief Engineer of the Hawaiian railway.

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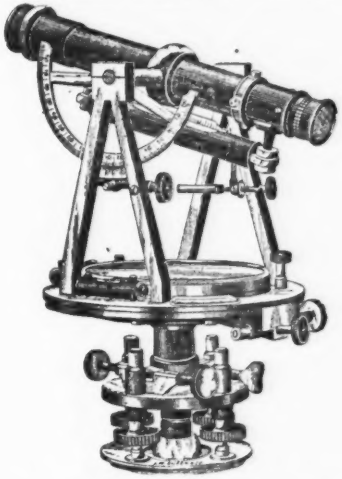

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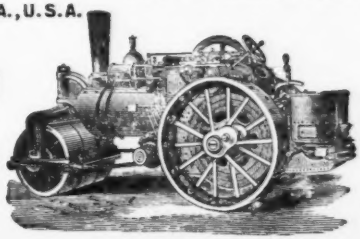

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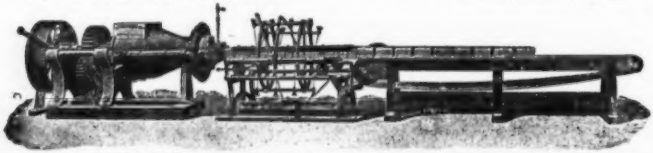

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Lane & Bodley Co., Cincinnati, Ohio.
Walburn-Swenson Co., Chicago, Ill.

Condensers, Jet.

Deane Steam Pump Co., Holyoke, Mass.
Lane & Bodley Co., Cincinnati, Ohio.
Wheeler Condenser and Eng. Co., 92 Liberty St., N.Y.

Condensers, Surface.

Edw. P. Allis Co., Milwaukee, Wis.
Wm. Baragwanath & Son, Chicago, Ill.
Gordon Steam Pump Co, Hamilton, Ohio.
Guild & Garrison, Brooklyn, N. Y.
Lane & Bodley Co., Cincinnati, Ohio.
Wheeler Condenser & Eng. Co., 92 Liberty St., N. Y.

Contractors' Supplies.

Thomas Carlin's Sons, Allegheny, Penna.
Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Cook Well Co., St. Louis Mo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Copeland & Bacon, 85 Liberty St., N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link-Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
John Souther & Co., Boston, Mass.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Conveying Machinery.

Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lane & Bodley Co., Cincinnati, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link Belt Engineering Co., Phila., Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Thomas Robins, Jr., 120 Liberty St., N. Y.
Wm. B. Scaife & Sons, Pittsburg, Pa.

Corliss Engines.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
M. C. Bullock Mfg. Co., Chicago, Ill.
Frick Company, Waynesboro, Pa.
Lane & Bodley Co., Cincinnati, Ohio.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Robt. Wetherill & Co., Chester, Pa.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Merchant & Co., Phila., Pa.
Wm. B. Scaife & Sons, Pittsburg, Pa.

Cornice Work, Galvanized Iron.

Kinnear & Gager Co., Columbus, Ohio.
W. H. Mullins, Salem, Ohio.

Cranes.

Berlin Iron Bridge Co., East Berlin, Conn.
Bucyrus Steam Shovel & Dredge Co., Bucyrus, O.
Copeland & Bacon, 85 Liberty st., N. Y.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Maris & Beekley, Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.
Yale & Towne Mfg. Co., Stamford, Conn.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.

Crushers, Ore, Phosphate Rock.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Fertilizer Co., Boston, Mass.
Thomas Carlin's Sons, Allegheny, Penna.
Beckett Foundry and Machine Co., Arlington, N. J.
Copeland & Bacon, 85 Liberty St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Totten & Hogg, Iron and Steel Foundry Co., Pittsburg, Pa.
Chrome Steel Works, Brooklyn, N. Y.

Damper Regulators.

Mason Regulator Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Desks.

A. H. Andrews & Co., Chicago, Ill.
Derby & Kilmer Desk Co., New York and Boston.

Diamond Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N.Y.
Stearns Bros, 62 Ann St., New York.
Sullivan Machinery Co., Chicago, Ill.

Dies.

Crescent Steel Co., Pittsburgh, Pa.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Niagara Stamping and Tool Co., Buffalo, N. Y.
Pratt & Whitney Co., Hartford, Conn.

Die and Drill Steel.

Crescent Steel Co., Pittsburgh, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.

Drawing Instruments.

Keuffel & Esser Co., 127 Fulton St., N. Y.
Theo. Alteneder & Sons, Philadelphia, Pa.
Queen & Co., Philadelphia, Pa

Dredging Machines.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Osgood Dredge Co, Albany, N. Y.
John Souther & Co, Boston, Mass.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N.Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Oil Well Supply Co., Pittsburgh, Pa.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

W. F. & J. Barnes Co., Rockford, Ill.
Boynton & Plummer, Worcester, Mass
Dwight Slate Machine Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Drop Forgings.

Billings & Spencer Co., Hartford, Conn.

Drop Presses.

Niagara Stamping and Tool Co, Buffalo, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Dynamos.

Belknap Motor Co., Portland, Me.
Card Electric Motor & Dynamo Co., Cincinnati, O.
Eddy Electric Mfg. Co., Windsor, Conn.
Jeffrey Mfg. Co., Columbus, Ohio.
Simpson Electric Mfg. Co, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electric Railway Supplies.

Card Electric Motor & Dynamo Co., Cincinnati, O.
J. Jones & Son, 39 Vesey St., N. Y.
C. S. Knowles, Boston, Mass.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Instruments.

Card Electric Motor & Dynamo Co., Cincinnati, O.
Heisler Electric Co., Philadelphia, Pa.
J. Jones & Son, 39 Vesey St., N. Y.
Eddy Electric Mfg. Co., Windsor, Conn.
Simpson Electric Mfg. Co., Chicago, Ill
Standard Thermometer Co., Peabody, Mass.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electrical Rubber Goods.

B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
C. S. Knowles, Boston, Mass.
Newton Rubber Co., Boston, Mass.

Elevators, Steam, Hydraulic, Electric.

Graves Elevator Co., Rochester, N. Y.
Howard Foundry and Machine Works, Phila.
Morse, Williams & Co., Philadelphia, Pa.
Otis Brothers & Co., 38 Park Row, New York.
Springfield Foundry Co., Springfield, Mass.
Thos. G. Laney, Lima, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Volney W. Mason & Co., Providence, R. I.

Emery Wheels.

J. Wendell Cole, Columbus, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.

Emery Wheel Machinery.

J. Wendell Cole, Columbus, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo. Alteneder & Sons, Brooklyn, N. Y.
Brandis Sons Co., Philadelphia, Pa.
Charles H. Brightly, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co. Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Cooke & Co., 163 Washington St., N. Y.
B. F. Sturtevant Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engines, Gas, Gasoline, and Petroleum.

Otto Gas Engine Works, Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.

Engines, Marine.

Rice & Whitacre Mfg. Co., Chicago, Ill.
Shipman Engine Co., Boston, Mass.

Engines, Portable.

Griffith & Wedge Co., Zanesville, Ohio.

Engines, Stationary.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
Buckeye Engine Co., Salem, Ohio.
M. C. Bullock Mfg. Co., Chicago, Ill.
Thomas Carlin's Sons, Allegheny, Penna.
Cooke & Co., 163 Washington St., N. Y.
Erie Engine Works, Erie, Penna.
Fairbanks, Morse & Co., Chicago, Ill.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Frick Company, Waynesboro, Pa.
Hooven, Owens & Rentschler, Co., Hamilton, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
John T. Noye Manufacturing Co., Buffalo, N. Y.
Oil Well Supply Co, Pittsburgh, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Shipman Engine Co., Boston, Mass.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
Totten & Hogg, Iron & Steel Foundry Co., Pittsburgh, Pa.
Webster, Camp & Lane Machine Co., Akron, O.
Robert Wetherill & Co., Chester, Penn.
Whitman & Barnes Mfg. Co., Syracuse, N. Y.

Engravers' Plates.

J. Wendell Cole, Columbus, Ohio.

Excavators.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Osgood Dredge Co., Albany, N. Y.
John Souther & Co., Boston, Mass.

Fans, Ventilating.

M. C. Bullock Mfg. Co., Chicago, Ill.

Feed-Water Heaters.

Wm. Baragwanath & Son, Chicago.
Edw. P. Allis Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Harrison Safety Boiler Works, Germantown Junction, Phila.
National Pipe Bending Co., New Haven, Conn.
Pennsylvania Machine Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Pa.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Whitlock Coil Pipe Co., Elmwood, Conn.
Goubert Mfg. Co., 32 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Fertilizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.

Filters.

Bradley & Company, Syracuse, N. Y.

Fire Arms.

Smith & Wesson, Springfield, Mass.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Fireproof Building Material.

Canton Steel Roofing Co., Canton, Ohio.
Berlin Iron Bridge Co., East Berlin, Conn.
Edward Darby & Sons, Philadelphia, Pa.
Lorillard Brick Works Co., 92 Liberty St., N. Y.
Pennsylvania Steel Co., Steelton, Pa.
Pioneer Fireproof Construction Co., Chicago, Ill.
Wm. B. Scaife & Sons, Pittsburg, Pa.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Flouring Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Dayton Globe Iron Works Co., Dayton, Ohio.

Flumes.

Rondey Hunt Machine Co., Orange, Mass.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Lane & Bodley Co., Cincinnati, Ohio.
Totten & Hogg Iron & Steel Foundry Co., Pittsburgh, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Forges.

Buffalo Forge Co., Buffalo, N. Y.
Cooke & Co., 163 Washington St., N. Y.
Pennsylvania Machine Co., Philadelphia, Pa.
B. F. Sturtevant Co., Boston, Mass.

Forgings.

Billings & Spencer Co., Hartford, Conn.
Crescent Steel Co., Pittsburgh, Pa.

Furnace Builders.

Griffith & Wedge Co., Zanesville, Ohio.
Julian Kennedy, Pittsburgh, Pa.

Furniture and Chair Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.
John A. White Co., Dover, N. H.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.

Gate Valves.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Continental Iron Works, Brooklyn, N. Y.
Jenkins Brothers, 71 John St., N. Y.
Pancoast & Rogers, 22 Platt St., New York.

Gauges, Steam.

Crosby Steam Gage and Valve Co., Boston, Mass.
Standard Thermometer Co., Peabody, Mass.

Gear Cutters.

E. Horton & Son Co., Windsor Locks, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Pennsylvania Machine Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Globe Iron Works Co., Dayton, Ohio.
Griffith & Wedge Co., Zanesville, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Pennsylvania Steel Co., Steelton, Pa.
Wm. B. Scaife & Sons, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Grates.

Samuel H. French & Co., Philapelphia, Pa.

Grinding and Polishing Machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Diamond Machine Co., Providence, R. I.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
J. Wendell Cole, Columbus, Ohio.

Grips, Cable Railways.

Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Hangers.

SEE PULLEYS, ETC.

Hardware Manufacturers.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass.
Volney W. Mason & Co., Providence, R. I.
Yale & Towne Mfg. Co., Stamford, Conn.

Heating and Ventilating Apparatus.

Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Cooke & Co., 163 Washington St., N. Y.

Heaters, Steam and Hot Water.

Capitol Heater Co., Detroit, Mich.
Boynton Furnace Co., 207 Water St., New York.
Broomell, Schmidt & Co., Ltd., York, Pa.
W. C. Mowry, Norwich, Conn.
H. B. Smith Co., 137 Center St., N. Y.
S. Wilks Mfg. Co., Chicago, Ill.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Beckett Foundry and Machine Co., Arlington, N. J.
Boston & Lockport Block Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Thomas Carlin's Sons, Allegheny, Penna.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Copeland & Bacon, 85 Liberty St., N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Fulton Iron and Engine Works, Detroit, Mich.
Griffith & Wedge Co., Zanesville, Ohio.
Edwin Harrington, Son & Co., Philadelphia, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Volney W. Mason & Co., Providence, R. I.
Maris & Beekley, Philadelphia, Pa.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Rice & Whitacre Mfg. Co., Chicago, Ill.
Webster, Camp & Lane Machine Co., Akron, O.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Walker Manufacturing Co., Cleveland, Ohio.
Yale & Towne Mfg. Co., Stamford, Conn.

Hollow Bricks.

Lorillard Brick Works Co., 92 Liberty St., N. Y.
Pioneer Fireproof Construction Co., Chicago, Ill.

Hose, Steam and Fire.

Crosby Steam Gage and Valve Co., Boston, Mass.
B. F. Goodrich Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.

Hydraulic Machinery.

Watson & Stillman, 204 E. 43d St., N. Y.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Crosby Steam Gage and Valve Co., Boston, Mass.

Injectors.

Wm. Sellers & Co., Philadelphia, Pa.
Penberthy Injector Co., Detroit, Mich.
Sherwood Mfg. Co., Buffalo, N. Y.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulating Compounds

Standard Paint Co., 2 Liberty St., N. Y.

Insulating Papers.

Standard Paint Co., 2 Liberty St., N. Y.

Insulated Wire.

Crescent Ins. Wire & Cable Co., Trenton, N. J.
C. S. Knowles, Boston, Mass.

Merchant & Co., Philadelphia, Pa.
The Okonite Co., Limited, 13 Park Row, N. Y.

Iron Working Machinery.

W. F. & J. Barnes Co., Rockford, Ill.
Betts Machine Co., Wilmington, Del.
Billings & Spencer Co., Hartford, Conn.
Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dwight Slate Machine Co., Hartford, Conn.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hill, Clark & Co., Chicago, Ill.
E. Horton & Son Co., Windsor Locks, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Walker Manufacturing Co., Cleveland, Ohio.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.
Wm. B. Scaife & Sons, Pittsburg, Pa.

Lathes.

W. F. & J. Barnes Co., Rockford, Ill.
Betts Machine Co., Wilmington, Del.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Edwin Harrington, Son & Co., Philadelphia, Pa.
Hill, Clark & Co., Chicago, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Sebastian Lathe Co., Cincinnati, Ohio.
Wm. Sellers & Co., Philadelphia, Pa.
Totten & Hogg, Iron & Steel Foundry Co., Pittsburgh, Pa.

Lamps.

Pittsburgh Brass Co., Pittsburgh, Pa.

Lamps, Electric.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Locomotives.

Baldwin Locomotives Works, Philadelphia, Pa.

Locomotive Brakes.

New York Air Brake Co., 115 Broadway, N. Y.
Westinghouse Air Brake Co., Pittsburgh, Pa.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Sherwood Mfg. Co., Buffalo, N. Y.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools.

W. F. & J. Barnes Co., Rockford, Ill.
Betts Machine Co., Wilmington, Del.
Billings & Spencer Co., Hartford, Conn.
Boynton & Plummer, Worcester, Mass.
Brainard Milling Machine Co., Hyde Park, Mass.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cooke & Co., 163 Washington St., N. Y.
Edwin Harrington, Son & Co., Philadelphia, Pa.
E. Horton & Son Co., Windsor Locks, Conn.
Hill, Clarke & Co., Chicago, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
National Machinery Co., Tiffin, Ohio.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
John A. White Co., Dover, N. H.

Machinists' Tools and Supplies.

W. F. & J. Barnes Co.o., Rockford, Ill.
Billings & Spencer, Hartford, Conn.
Bridgeport Machine Tool Works, Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
J. Wendell Cole, Columbus, Ohio.
Cooke & Co., 163 Washington St., N. Y.
Dwight Slate Machine Co., Hartford, Conn.
E. Horton & Son Co., Windsor Locks, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Long & Allstatter Co., Hamilton, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Sebastian Lathe Co., Cincinnati, Ohio.
J. Stevens Arms & Tool Co., Chicopee Falls, Mass.

Mantels.

Samuel H. French &. Co., Philadelphia, Pa.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Charles H. Brightly, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., N. Y.
Queen & Co., Philadelphia, Pa.

Merchant Steel.

Chester Steel Castings Co., Phila., Pa.
Crescent Steel Co., Pittsburgh, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Metal Separator.

Ezra Sawyer, Worcester, Mass.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Milling Machines.

Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.

Mining Screens.

Beckett Foundry and Machine Co., Arlington, N. J.
Copeland & Bacon, 85 Liberty St., N. Y.
Harrington & King Perf. Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Ludlow-Saylor Wire Co., St. Louis, Mo.

Mining Machinery.

Beckett Foundry and Machine Co., Arlington N. J.
Bradley Fertilizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Copeland & Bacon, 85 Liberty St., N. Y.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.
Gates Iron Works, Chicago, Ill.
Griffith & Wedge Co., Zanesville, Ohio.
Harrington & King, Perf. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N. Y.
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Niagara Steam Pump Works, 34 Dey St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Totten & Hogg Iron & Steel Foundry Co., Pittsburgh, Pa
Trenton Iron Co., Trenton, N. J.
Walburn-Swenson Co., Chicago, Ill.
Waldo & Stout, Bridgeport, Conn.
Webster, Camp & Lane Machine Co. Akron, O.

Motors, Electric.

Belknap Motor Co., Portland, Me.
Card Electric Motor & Dynam Co., Cincinnati, O.
Eddy Electric Mfg. Co., Windsor, Conn.
Jeffrey Mfg. Co., Columbus, Ohio.
Simpson Electric Mfg. Co., Chicago, Ill
Standard Thermometer Co., Peabody, Mass.
Westinghouse Electric & Mfg Co., Pittsburgh, Pa.

Motors, Water.

Belknap Motor Co., Portland, Me.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Oil Cups, Glass.

Sherwood Mfg. Co., Buffalo, N. Y.

Ornaments, Stamped Sheet Metal.

Kinnear & Gager Co., Columbus, Ohio.
W. H. Mullins, Salem, Ohio.

Packing.

Home Rubber Co., Trenton, N. J.
Garlock Packing Co., Palmyra, N. Y.
B. F. Goodrich Co., Akron, Ohio.
Jenkins Bros., 71 John St. N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

Packing House Machinery.

Walburn-Swenson Co., Chicago, Ill.

Paints.

Canton Steel Roofing Co., Canton, Ohio.
Joseph Dixon Crucible Co., Jersey City, N.J.
Samuel H. French & Co., Philadelphia, Pa.
Harrison Bros. & Co., Philadelphia, Pa.
Standard Paint Co., 2 Liberty St., N. Y.

Paper Mill Machinery.

Dayton Globe Iron Works, Dayton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Moore & White Co., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Patent Attorneys.

Du Bois & Du Bois, Washington, D. C.
Franklin H. Hough Washington, D. C.
Munn & Co., 361 Broadway, N. Y.
H. F. Parker, 135 Broadway, New York.
Wm. A. Rosenbaum, 177 Times B'ld'g, New York.
G. G. Turri & Co., Melbourne, Australia.
John A. Wiedersheim, Philadelphia, Pa.

Penstocks.

Rodney Hunt Machine Co., Orange, Mass.

Perforated Metal.

Harrington & King, Perf. Co., Chicago, Ill.
Merchant & Co., Philadelphia, Pa.

Photographic Supplies.

Rochester Optical Co., Rochester, N. Y.

Pile Drivers.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Pipe Casings, etc.

Oil Well Supply Co., Pittsbrugh, Pa.
Pancoast & Rogers, 22 Platt St., New York.
A. Wyckoff & Son, Elmira, N. Y.

Pipe, Cast Iron.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Ohio Pipe Co., Columbus, Ohio.
Pancoast & Rogers, 22 Platt St., New York.
Walker Manufacturing Co., Cleveland, Ohio.

Pipe, Coils and Bends.

National Pipe Bending Co., New Haven, Conn.

Pipe Cutting and Threading Machines.

Curtis & Curtis, Bridgeport, Conn.
Bignall & Keeler Mfg. Co., St. Louis, Mo.
Pennsylvania Machine Co., Philadelphia, Pa.

Pipe-Spiral Riveted.

Abendroth & Root Mfg. Co., New York.
Merchant & Co., Philadelphia, Pa.

Pipe Threading Lathe Attachments.

Curtis & Curtis, Bridgeport, Conn.

Pipe Vises.

Curtis & Curtis, Bridgeport, Conn.

Pipe, Wrought Iron, Line and Drive.

Oil Well Supply Co., Pittsburgh, Pa.
Pancoast & Rogers, 22 Platt St., New York.

Planing Mill Machinery.

The Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Pennsylvania Machine Co., Philadelphia, Pa.
C. B. Rogers & Co., Norwich, Conn.
John A. White Co., Dover, N. H.

Plumbing and Sanitary Goods.

Standard Mfg. Co., Pittsburgh, Pa.

Portable Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Power Punches and Shears.

Long & Allstatter Co., Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.

Presses, Baling.

Boomer & Boschert Press Co., Syracuse, N. Y.
Watson & Stillman, 204 E. 43d St., N. Y.

Presses, Hydraulic

Boomer & Boschert Press Co., Syracuse, N. Y.
Niles Tool Works, Hamilton, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.

Pressure Regulators.

Mason Regulator Co., Boston, Mass.
Rodney Hunt Machine Co., Orange, Mass.
Standard Thermometer Co., Peabody, Mass.

Prospecting Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Stearns Bros., 62 Ann St., New York.
Sullivan Machinery Co., Chicago, Ill.

Pulley Lathes.

W. F. & J. Barnes Co., Rockford, Ill.

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Edw. P. Allis Co., Milwaukee, Wis.
Cooke & Co., 163 Washington St., N. Y.
Dayton Globe Iron Works, Dayton, Ohio.
Griffith & Wedge Co., Zanesville, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Lane & Bodley Co., Cincinnati, Ohio.
Moore & White Co., Philadelphia, Pa.
Pennsylvania Machine Co., Philadelphia, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.
Volney W. Mason & Co., Providence, R. I.
Walker Manufacturing Co., Cleveland, Ohio.

Pulverizers.

Bradley Fertilizer Co., Boston, Mass.
Frisbee-Lucop Mill Co., 145 Broadway, N. Y.

Pumps and Pumping Machinery.

Edw. P. Allis Co. Milwaukee, Wiss.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooke & Co., 163 Washington St., N. Y.
M. T. Davidson, Brooklyn, N. Y.
Thos. G. Laney, Lima, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
Gordon Steam Pump Co., Hamilton, Ohio.
Guild & Garrison, Brooklyn, N. Y.
Holly Mfg. Co., Lockport, N. Y.
Knowles Steam Pump Works, New York.
Laidlaw & Dunn Co., Cincinnati, Ohio.
Niagara Steam Pump Works, 34 Dey St., N. Y.
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U. S. Wind Engine and Pump Co., Batavia, Ill.
Watson & Stillman, 204 E. 43d St., N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
Webster, Camp & Lane Machine Co., Akron, O.
Wheeler Condenser & Eng. Co., 92 Liberty St., N. Y.
Henry R. Worthington, 86-88 Liberty St., N. Y.

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Mason Regulator Co., Boston, Mass.

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Long & Allstatter Co., Hamilton, Ohio.
Miner & Peck Mfg. Co., New Haven, Conn.
Niagara Stamping and Tool Co., Buffalo, N. Y.
Walker Manufacturing Co., Cleveland, Ohio.
Watson & Stillman, 204 E. 43d St., N. Y.

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A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Ingersoll-Sergeant Drill Co., 10 Park Pl., N. Y.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
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H. B. Smith Co., 137 Center St., N. Y.

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O. S. Kelly Co., Springfield, Ohio.
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Bradley Fertilizer Co., Boston, Mass.
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Lane & Bodley Co., Cincinnati, Ohio.
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Harrington & King, Perf. Co., Chicago, Ill.

Separators, Metal.

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Separators, Steam.

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The Goubert Mfg. Co., 32 Cortlandt St., N. Y

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Niagara Stamping and Tool Co., Buffalo, N. Y.

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Niagara Stamping and Tool Co., Buffalo, N. Y.

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Buckeye Engine Co., Salem, Ohio.

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Chrome Steel Works, Brooklyn, N. Y.

Steam Fitters' Supplies.

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Chapman Valve Mfg. Co., Indian Orchard, Mass.
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Mason Regulator Co., Boston, Mass.
Sherwood Mfg. Co., Buffalo, N. Y.
Standard Thermometer Co., Peabody, Mass.
Van Auken Steam Speciality Co., Chicago, Ill.

Steam Shovels.

Bucyrus Steam Shovel and Dredge Co., Bucyrus, O.
Marion Steam Shovel Co., Marion, Ohio.
Osgood Dredge Co., Albany, N. Y.
John Souther & Co., Boston, Mass.

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The Goubert Mfg. Co., 32 Cortlandt St., N. Y.
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Merchant & Co., Philadelphia, Pa.

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Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Pennsylvania Steel Co., Steelton, Pa.
Standard Steel Casting Co., Thurlow, Pa.

Steel, Tool.

Crescent Steel Co., Pittsburgh, Pa.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.

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Newton Rubber Co., Boston, Mass.

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Berlin Iron Bridge Co., East Berlin, Conn.
Pennsylvania Steel Co., Steelton, Pa.
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Wm. Baragwanath & Son, Chicago, Ill.
Continental Iron Works, Brooklyn, N. Y.

Tanks, Portable.

O. S. Kelly Co., Springfield, Ohio.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

Telegraph Wires and Cables.

Crescent Ins. Wire & Cable Co., Trenton, N. J
C. S. Knowles, Boston, Mass
John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

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Standard Thermometer Co., Peabody, Mass.

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Riehle Bros. Testing Machine Co., Philadelphia, Pa.
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Thermometers.

Standard Thermometer Co., Peabody, Mass.

Tiles.

Samuel H. French & Co., Philadelphia, Pa.

Time Detectors.

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E. Imhauser, 206 Broadway, New York.

Tin Plates.

Gummey, Spering & Co., Philadelphia, Pa.
Merchant & Co., Philadelphia, Pa.

Tinners Tools and Machines.

Niagara Stamping and Tool Co., Buffalo, N. Y.

Tramways.

Edwin Harrington, Son & Co., Philadelphia, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Walker Manufacturing Co., Cleveland, Ohio.

Tramways, Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Trenton Iron Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
C. W. Hunt Co., 45 Broadway, N. Y.

Transmission Machinery.

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Lane & Bodley Co., Cincinnati, Ohio.
Walker Manufacturing Co., Cleveland, Ohio.
Robt. Wetherill Co., Chester, Pa.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
C. W. Hunt Co., 45 Broadway, N. Y.

Tube Scrapers.

Sherwood Mfg. Co., Buffalo, N. Y.

Tube Well Supplies.

Cook Well Co., St. Louis, Mo.
Oil Well Supply Co., Pittsburgh, Pa.

Turbines.

Dayton Globe Iron Works, Dayton, Ohio.

Turn Tables.

Wm. Sellers & Co., Philadelphia, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Typewriters.

Wyckoff, Seamans & Benedict, Boston, Mass.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mch. Co., New Bedford, Mass,
J. Wendell Cole, Columbus, Ohio.

Vacuum Pumps.

A. S. Cameron, Steam Pump Works, E. 23d St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.
Guild & Garrison, Brooklyn, N. Y.
Niagara Steam Pump Works, 34 Dey St., N. Y.
Henry R. Worthington, 86-88 Liberty St., N. Y.

Valves, Gas, Steam and Water.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Home Rubber Co., Trenton, N. J.
Jenkins Brothers, 71 John St., N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Mason Regulator Co., Boston, Mass.
Newton Rubber Co., Boston, Mass.
Pancoast & Rogers, 22 Platt St., New York.
Waldo & Stout, Bridgeport, Conn.
Standard Thermometer Co., Peabody, Mass.
Totten & Hogg, Iron & Steel Foundry Co., Pittsburgh, Pa.
Waston & Stillman, 204 E. 43d St., N. Y.

Varnishes.

Standard Paint Co., 2 Liberty St., N. Y.

Ventilating Appliances.

Cooke & Co., 163 Washington, St., N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Globe Ventilator Co., Troy N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
B. F. Sturtevant Co., Boston, Mass.

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Weston Electrical Ins. Co., Newark N. J.

Water Purifying Apparatus.

Wm. Baragwanath & Son, Chicago, Ill.

Water Supplies.

Cook Well Co., St. Louis, Mo.
Oil Well Supply Co., Pittsburg, Pa.

Water Wheels.

Dayton Globe Iron Works, Dayton, Ohio.
Pelton Water Wheel Co., San Francisco and New York.
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Well Drilling Machinery.

Oil Well Supply Co., Pittsburg, Pa.
Walburn-Swenson Co., Chicago, Ill.

Wind Engine.

U. S. Wind Engine and Pump Co., Batavia, Ill.

Wire.

Crescent Steel Co., Pittsburgh, Pa.
Ludlow-Saylor Wire Co., St. Louis, Mo.
Merchant & Co., Philadelphia, Pa.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Edward Darby & Sons, Philadelphia, Pa.
Harrington & King, Perf. Co , Chicago, Ill.
Ludlow-Saylor Wire Co., St. Louis, Mo.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wood Water Pipe.

A. Wyckoff & Son, Elmira, N. Y.

Wood-Working Machinery.

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J. A. Fay Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
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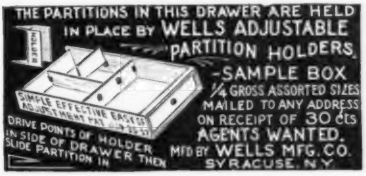
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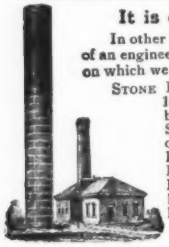

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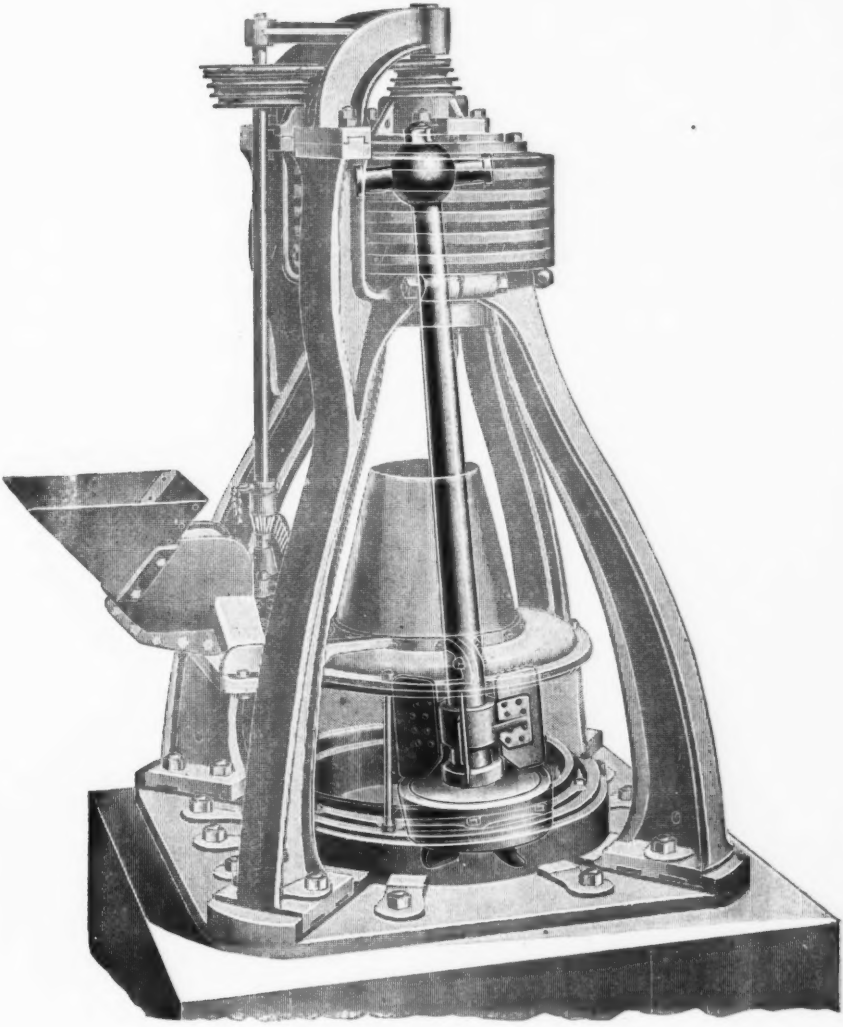

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The reduction of rock and ores of all kinds to a fine powder has always been attended with difficulty, and it has been one of the serious problems of designers to provide satisfactory machinery for this purpose. Buhrstones have been used for the softer rocks, and the old-fashioned stamp mills for the harder, but both of these methods have proved to be unsuited for general use, besides being very expensive to maintain.

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This Mill employs in its construction the principle of a roll running within and against a ring or die. Heretofore in all mills employing this principle the roll has been propelled by being pushed around by drivers, or carried on journals within the roll, and the friction and destruction of the pushing devices and journals has been great and involved loss of power and excessive wear and tear. To overcome this difficulty Mr. J. K. Griffin conceived the idea of positively revolving the roll on its own axis, and giving it freedom to swing outward against the die by use of a universal joint. The centrifugal force holds the roll in contact with the ring or die against which it runs. The device as described is claimed to embody a new mechanical movement which has not been employed heretofore in any kind of a machine. The roll is fixed rigidly on a solid shaft suspended from a pulley above by means of a universal joint, rotating with the pulley, the joint giving the shaft and roll freedom to swing outward when in operation, pressing against the ring or die. The roll is revolved within the die in the same direction that the shaft is driven, but when coming in contact with the die it travels around the die in the opposite direction from that in which the roll is revolving with the shaft, thus giving the Mill two direct actions on the material to be ground. There is a pressure by centrifugal force of 6000 pounds brought to bear on the material between the roll and die, the united actions being very effective in their combination.

The result of this peculiar roll movement is the production of a very fine uniform product, every particle of which is perfectly

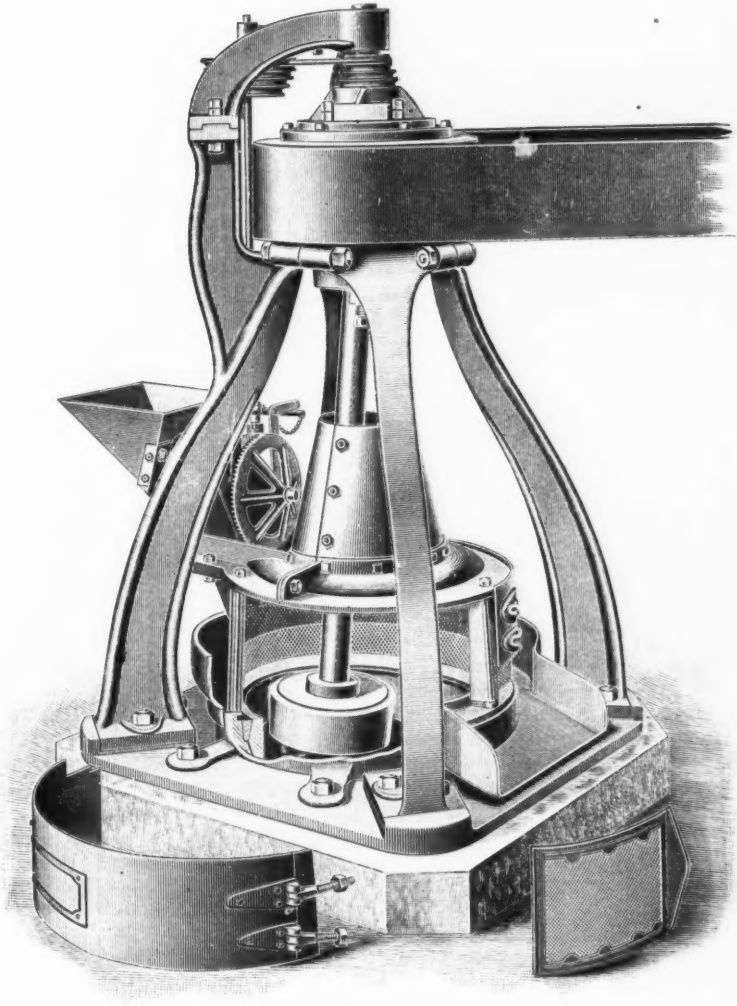

Fig 2.

THE GRIFFIN MILL.

(For wet grinding.)

fractured instead of being smoothly ground, as in buhrstone and other mills.

The perfect granulation of products ground by this Mill makes the mill especially suitable for reducing ores of all kinds, as the product leaves the mill in the best possible condition for either amalgamation or concentration.

Figure 1 is a perspective view of the Mill for dry grinding, and clearly shows its construction; the roll, shaft, and universal joint being in full line and the other parts in light lines.

The material to be ground is put into the automatic feeder which delivers it into the grinding chamber. In this chamber is the rapidly revolving roll with plows attached to the under side which take up the material and distribute it against the ring or die where it is crushed. As the whole mass of material is whirling around the fine portion rises to the top, and passes out through the screens, assisted by the fans on the shaft above the roll, which also bring in air at the top of the conical housing, forcing it out through the screens. After going through the screens the pulverized material passes through an opening into the receptacle underneath, from whence it can be conveyed wherever desired.

Figure 2 shows the Mill arranged for wet grinding.

In the wet grinding mill the fans are omitted. Water is introduced with the feed, and the produce is carried out through the screens into the surrounding trough which delivers it to amalgamators concentrators, or other saving apparatus.

The Griffin Mill is a splendid example of mechanical ingenuity, which wrought out by skilled mechanics from the best of materials, results in a strictly first-class mill of enormous capacity and great strength.

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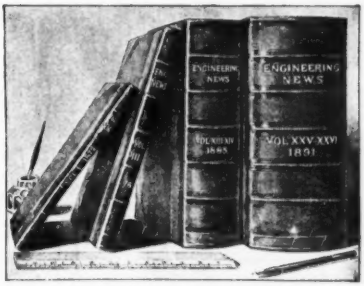

Engineering News

was started as a monthly on April 15, 1874, in Chicago; on January 1, 1876, it was changed to a weekly; on January 4, 1879, it was first issued from its present office in the Tribune Building, New York City. The following figures show its growth in pages and price:

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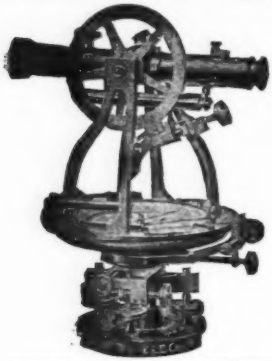

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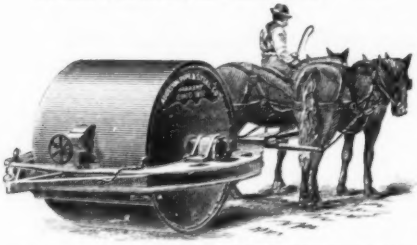

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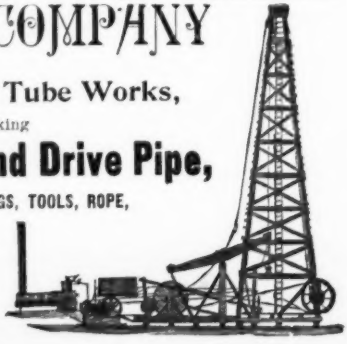


IMPROVED MACHINERY.

This department is designed for the description of improved machinery and new processes introduced by patrons of the magazine. The matter is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Utilization of Exhaust Steam.

THE Peck-Wheeler system of high temperture feed-water heating by combined live and exhaust steam is an improvement based upon the principle, hitherto not adequately appreciated, especially by American engineers, that the higher the temperature at which feed-water can be delivered to a boiler the longer the boiler will last, the less repairing it will need, and the less will scale form in it.

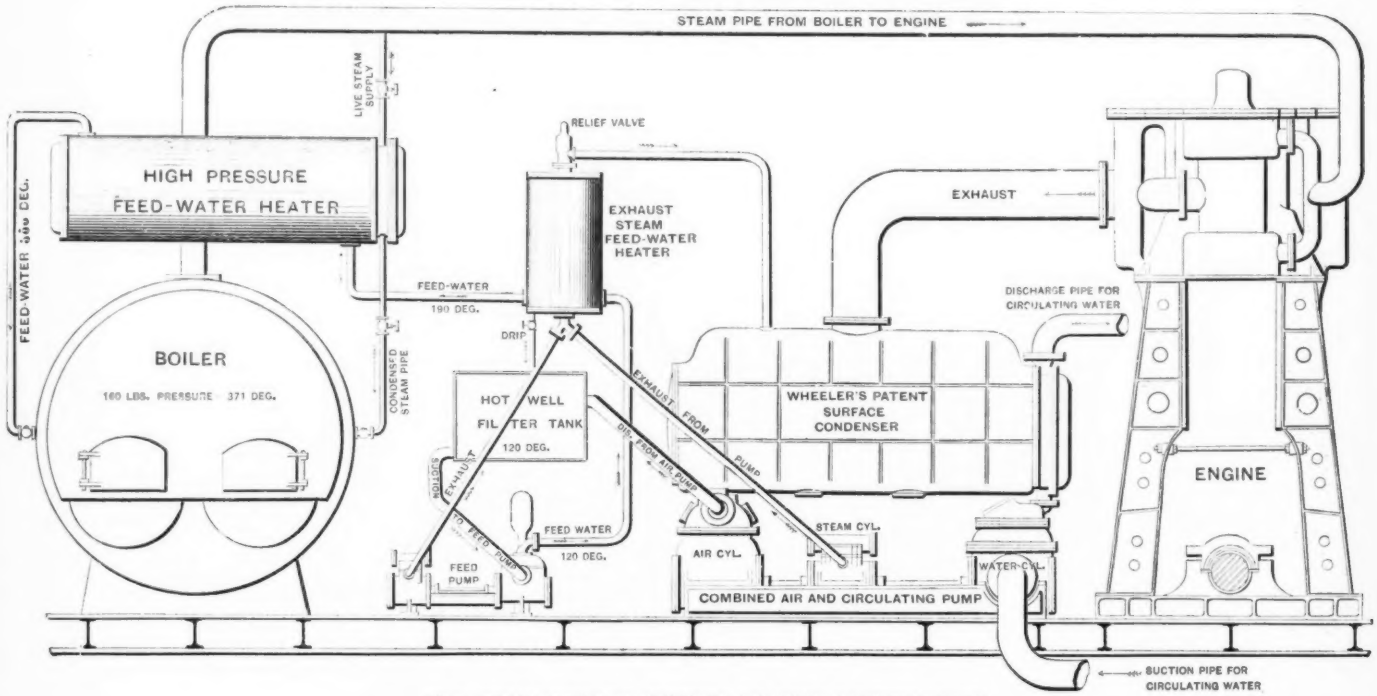
It needs no argument in the present state of knowledge relating to boilers to convince intelligent engineers that only by a high temperature in the feed approaching closely to that of the steam generated, can absolute immunity from the destructive influence of unequal expansion be avoided. It also should need no argument to show that, as heating feed-water causes it to precipitate mineral matters held in solution, a high temperature must be more effective in preventing such deposits in a boiler than a low one. Neither should it require argument to prove that, as all heat imparted to feed-water (even if primarily taken from the boiler, as is partly done in the Peck-Wheeler system), is restored to the boiler again, no reduction of economy could be suffered except some small surface radiation, by heating feed-water for a non-condensing engine wholly by live steam. But, when all the available heat in the exhaust steam is first utilized, and only sufficient live steam is taken from the boiler to complete the heating, the surface losses from the apparatus used for this purpose are much more than compensated for by resulting economies.

Years ago the heating of feed-water by live steam taken directly from the boiler was made the subject of experiment in the United States. While it was found that the purification of water by this means was much more effective than by previous methods in which lower temperatures were attained, for some reason not easily conjectured this line of experiment was never carried out to a satisfactory conclusion, and only more recently in England the method has been brought into use; and through more perfect appliances represented by what is known as the "Peck-Wheeler System," it has proved its value. This system has been patented and is now placed on the market in the United States. It has thus arrested the attention of the engineering world, the technical press representing steam engineering interests giving it particular notice.

At the average vacuum obtained in condensers, in good practice, the available temperature is about 120° F., and by the condensation of such exhaust steam, this temperature is the limit of possibility in heating feed-water. But this temperature is 250° below that of steam at 160 lbs. pressure; and to feed water at 120° into a boiler carrying steam at 160 lbs. pressure, would be as destructive as to feed water at 57° into a boiler carrying 60 lbs. As pressures as high or higher than 160 lbs. are now common in boilers of triple and quadruple expansion engines, it is seen that temperatures of feed-water that were satisfactory when lower pressures were used would now be destructive. The feed-water requires to be heated to a much higher temperature. Since this cannot be done by the exhaust steam, either live steam or some other special appliance for direct heating have become a necessity.

It can be shown that the system of putting in the necessary heat over and above that obtainable from exhaust steam by the use of live steam has special advantages, and this performed as described below constitutes the "Peck-Wheeler System."

The tension of water vapor at 120° F. is 3.427 inches of mercury; and this corresponds to a depression of the barometic mercury column of 26.573 inches, or as engineers would say a vacuum (of 26½ inches. In applying the method under consideration the air-pump is worked to produce this vacuum). The heat of the exhaust steam of the main engine is thus utilized as far as practicable consistently with a good working vacuum for heating the feed water, that is to say, the water of condensation issues from the surface-condenser at a temperature of about 120° and is delivered by the air pump into the "hot well filter-tank."



THE PECK-WHEELER SYSTEM OF HIGH TEMPERATURE
COMBINED LIVE AND EXHAUST STEAM FEED-WATER HEATING, PATENTED.

After thorough filtering, the water passes into the feed pump, whence it is delivered into an "exhaust steam feed-water heater," where it receives another increment of heat from the exhaust steam of the circulating pump, air-pump, and feed-pump, together with exhaust steam from any other small or auxiliary engine. Thus this heater performs the double function of a surface condenser for all the smaller engines, and a feed-water heater for the condensed water drawn from the main surface condenser; the condensed water from the combined exhaust of the small engines passing through a drip-pipe into the "hot well filter-tank," and there being also filtered and mixed with the condensed water from the main engine. The increment of temperature added to feed water in the exhaust steam feed-water heater, depends of course upon the number of small engines in use, but at this stage the temperature—from 180° to 190°—usually obtained—is yet too low for the water to pass into the boiler without injury to the latter.

The desired temperature is finally attained in the "high pressure feed-water heater" from live steam taken directly from the boiler or steam pipe, this heater also performing a double function, that of condensing a portion of the live steam and returning the water of condensation through the drip pipe to the boiler, and heating the feed-water to a temperature approximating that of the steam in the boiler.

The arrangement has been described as though a separate air-pump and circulating pump were used, as they might be, without in any wise departing from the Peck-Wheeler system.

The manufacturers of the apparatus, the Wheeler Condenser and Engineering Company of New York, use a combined air and circulating pump as indicated in the engraving, the latter also indicating very clearly the relative size, position, and general arrangement of the parts.

It is claimed for the apparatus that the following advantages are secured.

1st. An economy in use of fuel of from 6 to 10 per cent.

2d. An increase in the steaming capacity of the boiler of from 15 to 20 per cent.

3d. A nearly total obviation of strains due to unequal expansion, and consequent greatly increased durability of a boiler using the apparatus.

4th. A superior purification of the water during its progress through the heaters.

5th. The steam production is quicker and more uniform, and hence fluctuations of boiler pressure are very much reduced.

6th. Steam generating power for a given extent of heating surface being increased by the apparatus, the cost of a boiler that will deliver a given power is decreased; and as the boiler is rendered more durable, current expense for repairs is correspondingly reduced.

When water is rapidly circulating over heating-surface, as in the act of boiling, it absorbs from that surface much more heat in a given time than when circulating very slowly, as is the condition prior to ebullition. Hence arises the increased capacity of a boiler using the Peck-Wheeler system of feed-water heating.

The destructive effects of differential expansion are too well recognized to need any elaborate discussion. Assistant Engineer T. W. Kincaid, U. S. N., in a recent article printed in the *Journal of the American Society of Naval Engineers*, cites an example of a marine double-ended boiler, 20 feet long, wherein expansion between opposite parts of the shell amounted to one-third of an inch. The strains resulting from such an inequality of expansion must be extremely destructive in their effect and they can be entirely avoided by the use of the feed-water heating apparatus described. The same engineer in the same article refers to the efficiency of the tubes of surface condensers in extracting grease, and for the removal of mineral matters that otherwise would form scale; and speaking further of an English vessel, where live steam was employed to heat feed-water, he says that though the system was quite imperfect, five pounds higher boiler pressure was maintained and the firemen had less labor to perform while the number of revolutions of the engine was increased from 34 to 35½ per minute.

The Peck-Wheeler System is claimed to represent perfected practice in the application of this principle, a claim that appears to be very generally conceded, judging from the highly commendatory notices it has received in the columns of engineering publications of the highest repute.

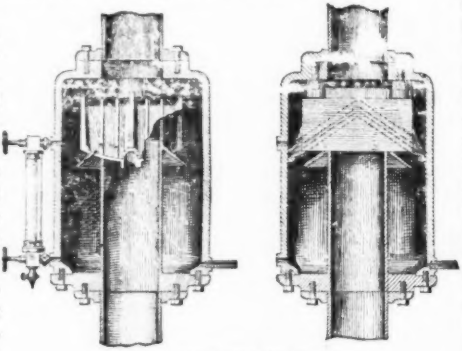
For Keeping Pay Rolls.

THE proprietors and managers of large industrial establishments will find in the new Pay Roll book invented by H. W. Scattergood, 25 Richmond street, Philadelphia, a novel device for keeping the time of a number of men. By its use a complete record of each employé is kept, and the necessary writing reduced to a minimum. A permanent sheet containing the name, and other matter, which can be used for an indefinite time, is partly covered by a narrow slip or sheet which is ruled to keep the time for

one week. The slips are filed after each pay day for future reference, a substantial binding for the book and one for the slips being provided, and the sheets on both are easily removed. Its economy of time and accuracy of record have secured its introduction in many leading establishments. Mr. Scattergood is himself the publisher of the book.

The Cochrane Separator.

ANOTHER form of the Cochrane Separator now covered by patents dated Feb. 4th, 1890, May 3d, 1892, and Oct. 11th, 1892, is shown in the accompanying cut, which illustrates the vertical style from two different points of view. The angular baffle plate, with its ribbed upper and lower faces, is designed to receive the impact either of an ascending or a descending current of steam, diverting the separated particles to the side, away from the passage for the purified current. The pipe projecting upwards in the separator is virtually a continuation of the main line, and forms the receptacle or well for the separated particles (water, oil, grease, grit, etc.). The umbrella-shaped projection at the top of this pipe is designed to contract the mouth of the well so as to prevent interference with the contents thereof. The general construction is similar to that previously described in the circulars of the manufacturers. The Harrison Safety Boiler Works, Germantown Junction, Philadelphia, Pa.



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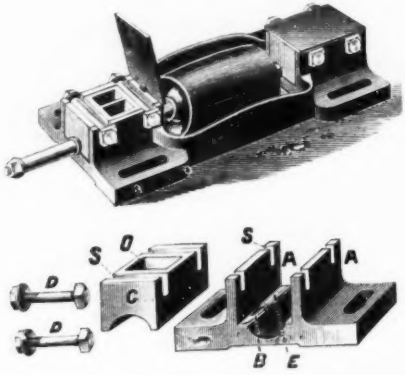

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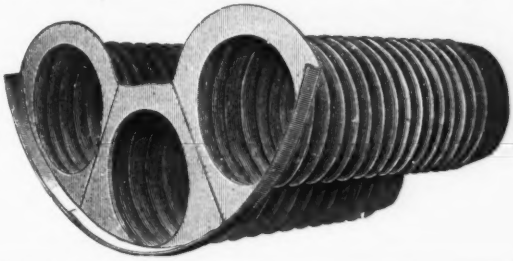

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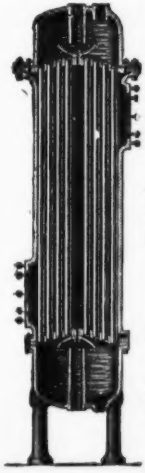

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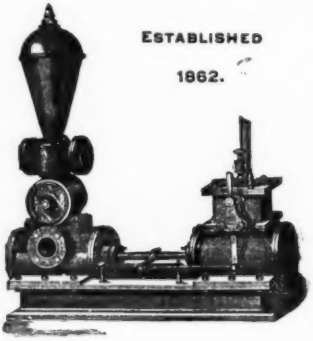

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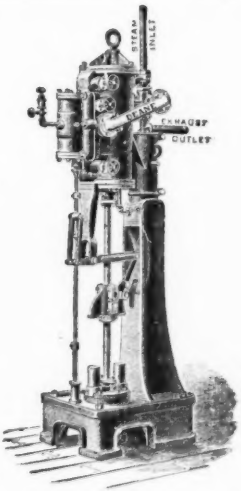

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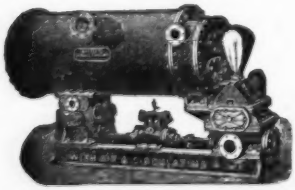

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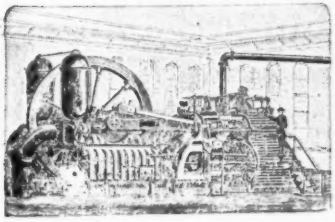

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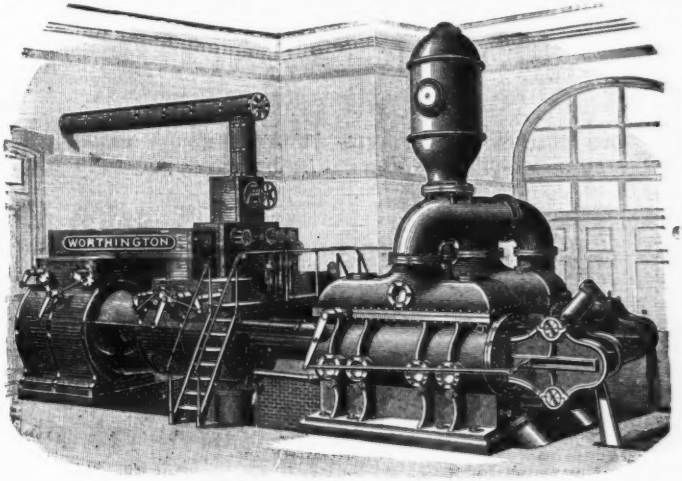

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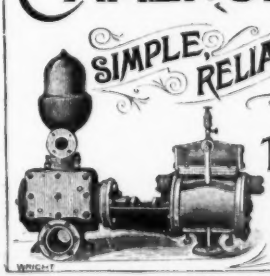

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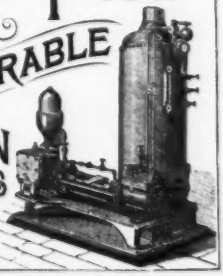

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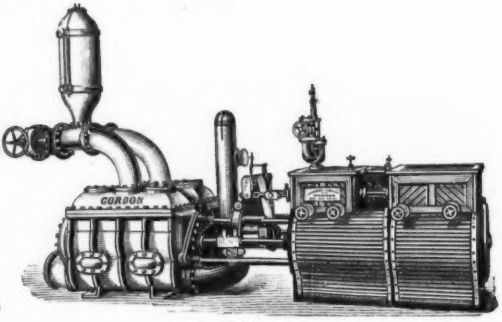

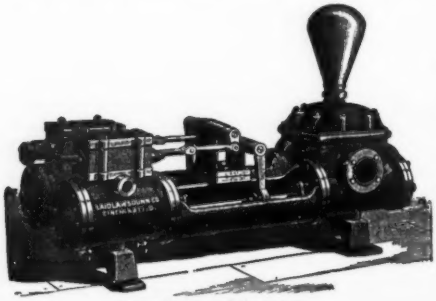

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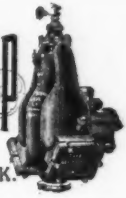

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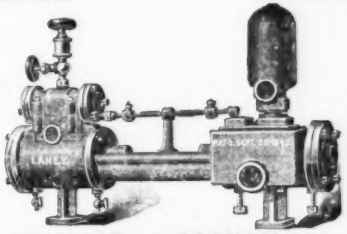

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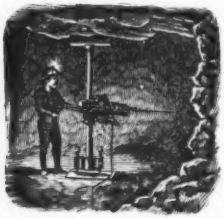

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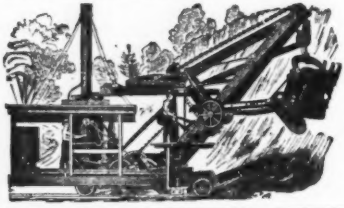

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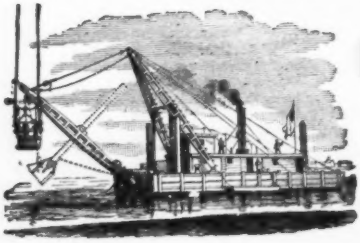

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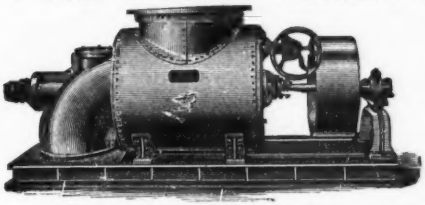

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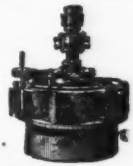

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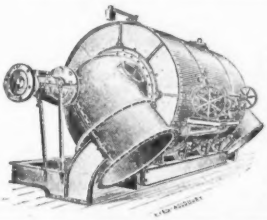

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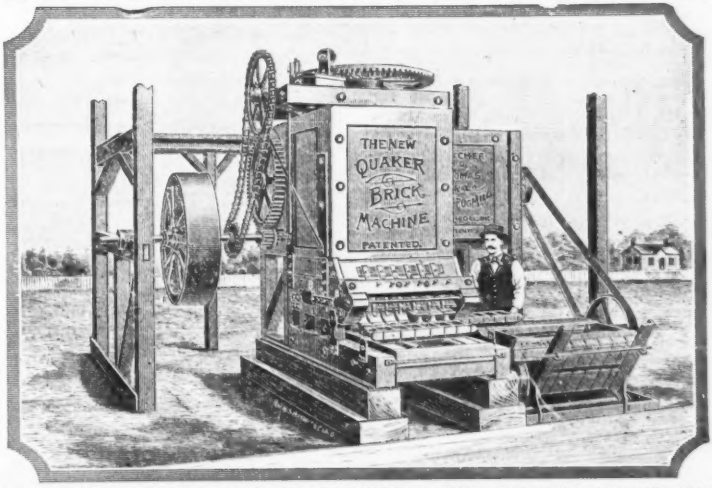

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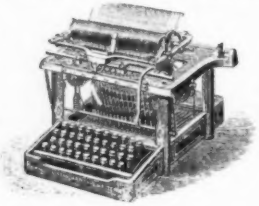

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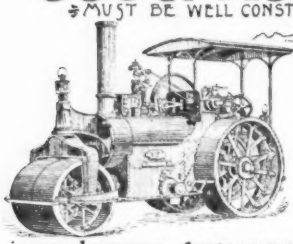

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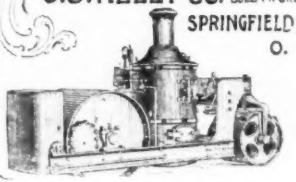

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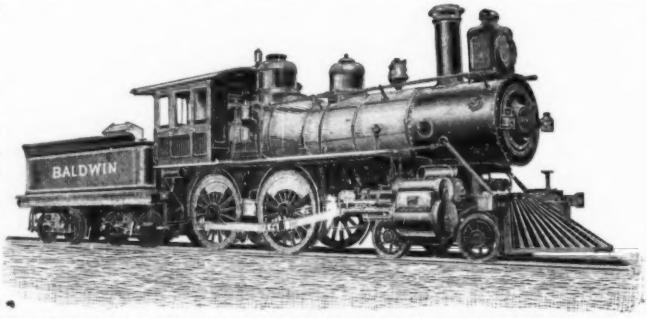

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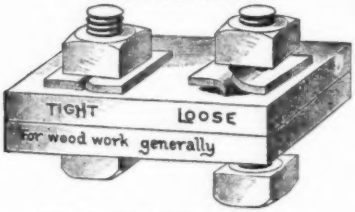

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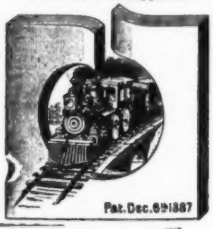

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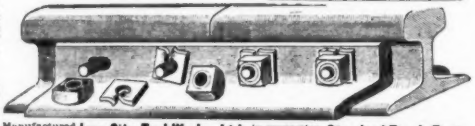

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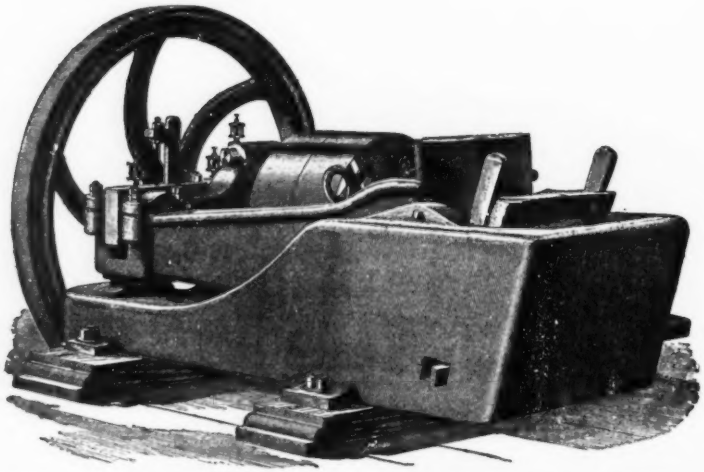

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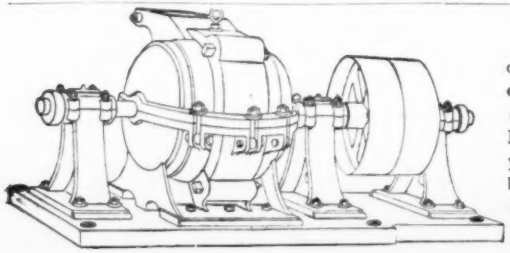

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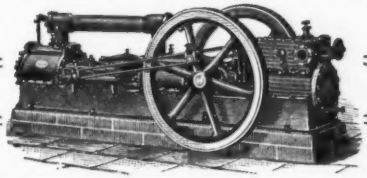

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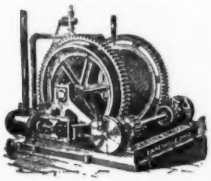

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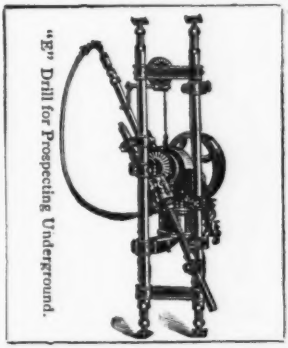

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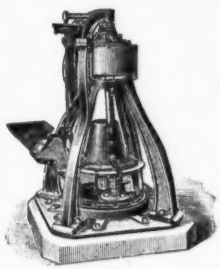

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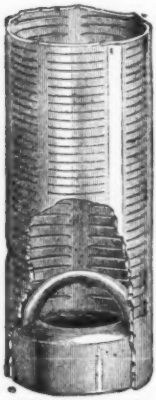

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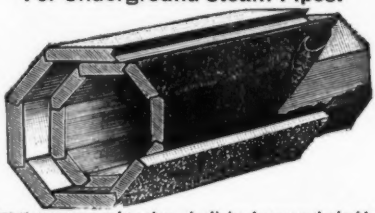

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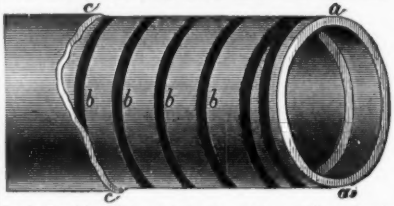

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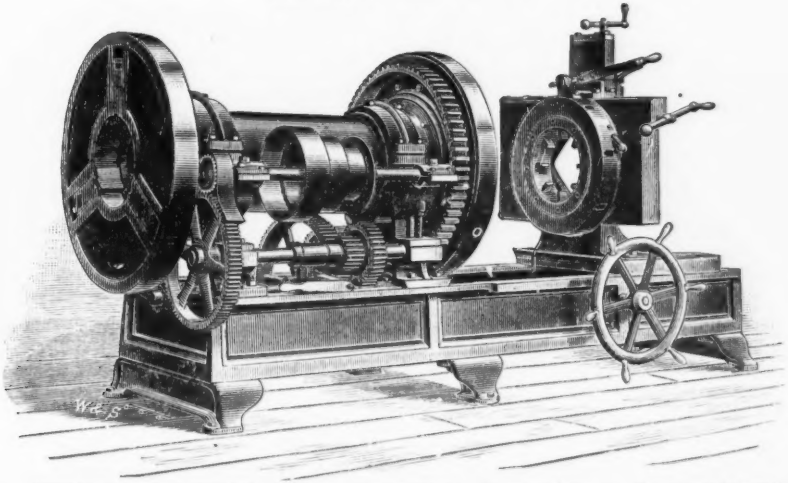

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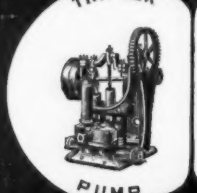

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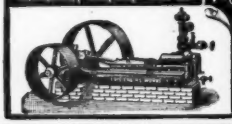

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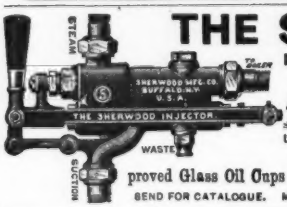

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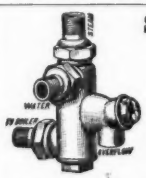

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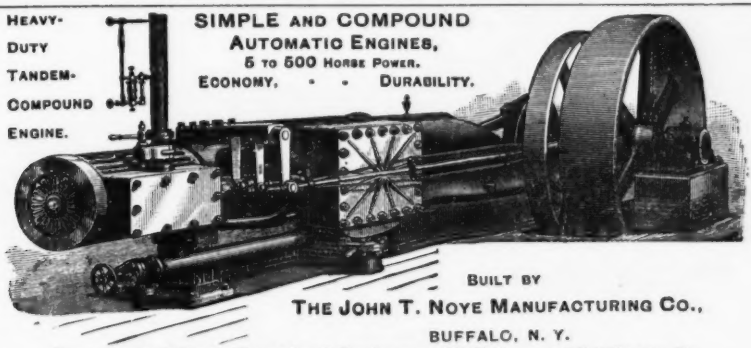

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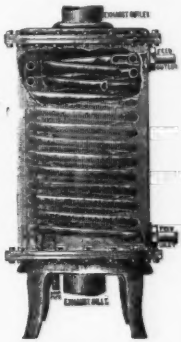

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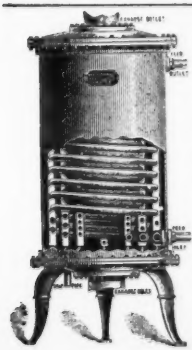

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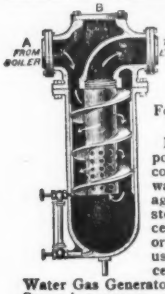

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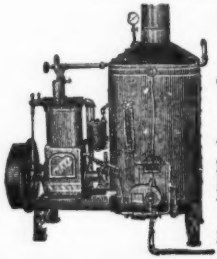

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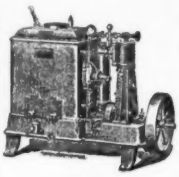

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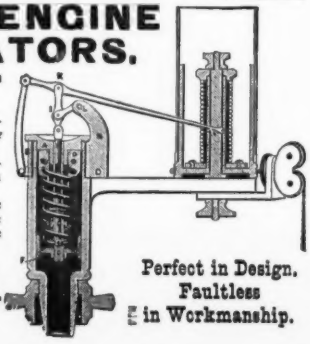

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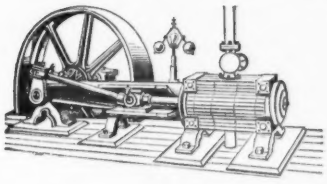

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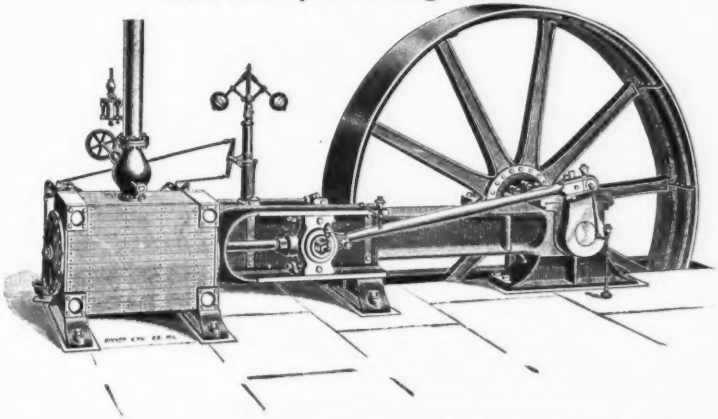

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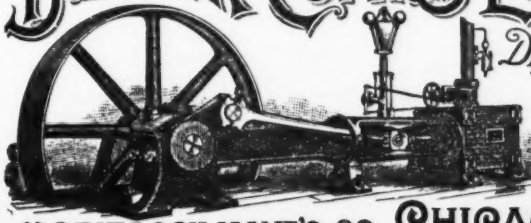

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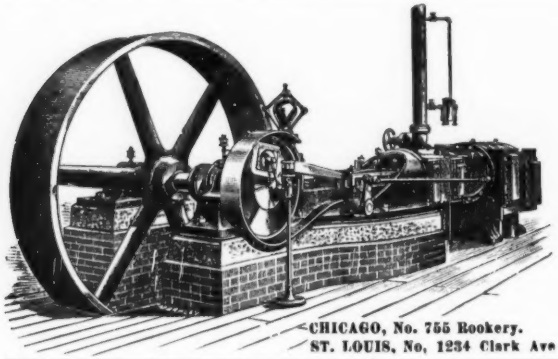

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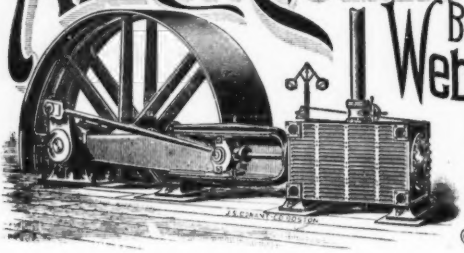

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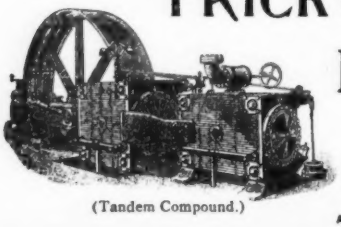

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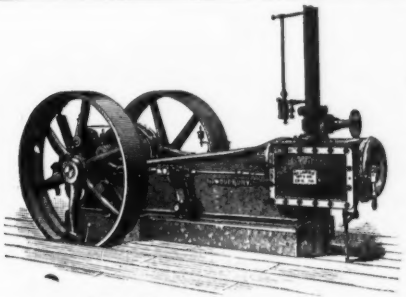

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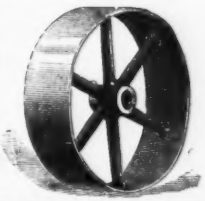

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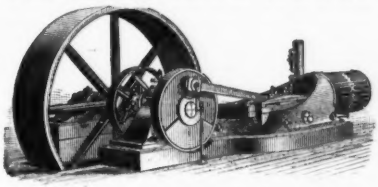

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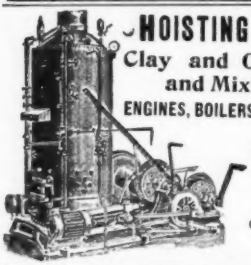

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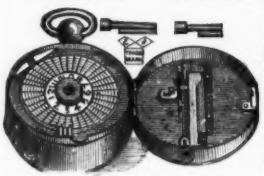

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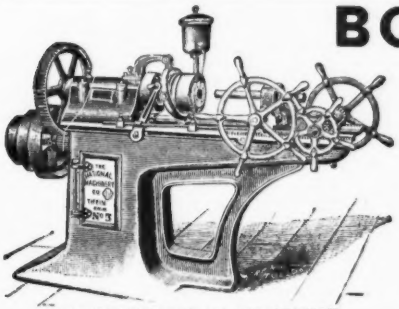

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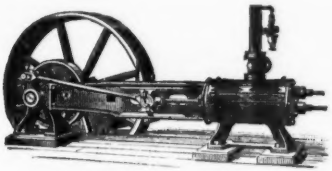

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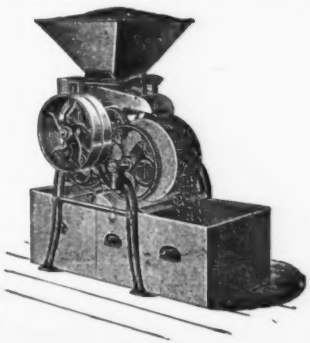

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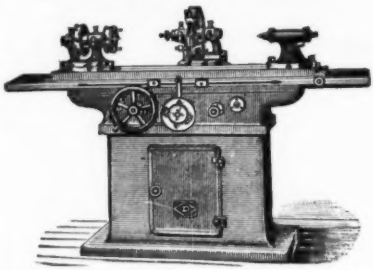

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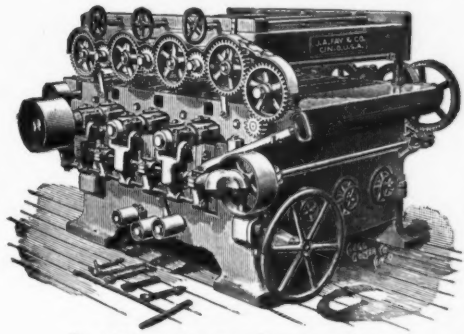

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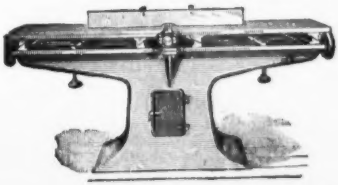

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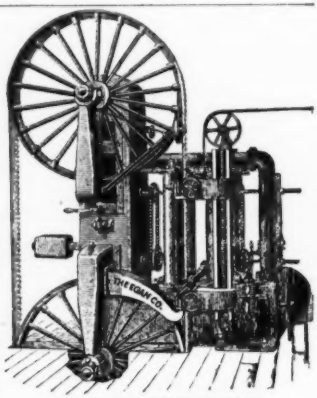

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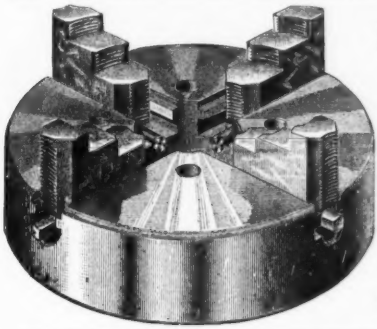

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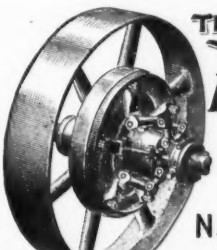

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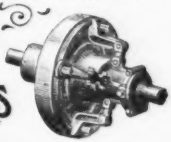

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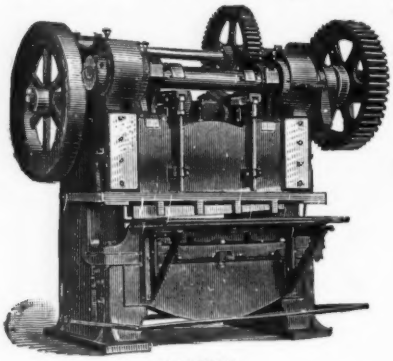

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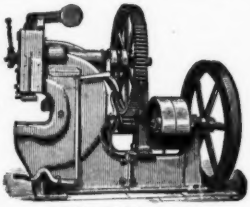

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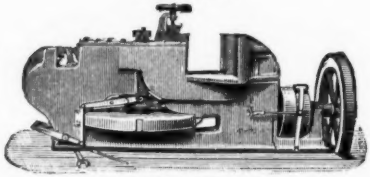

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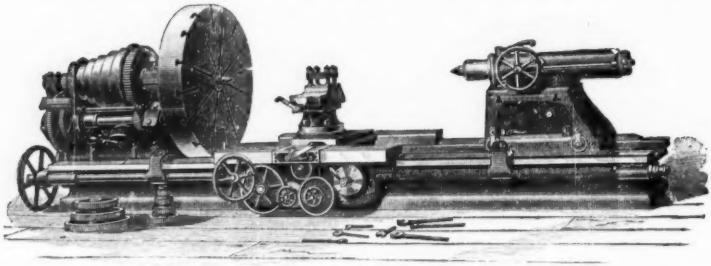

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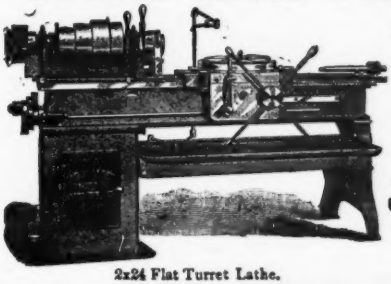

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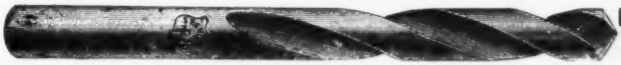

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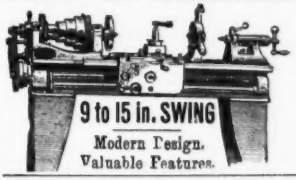

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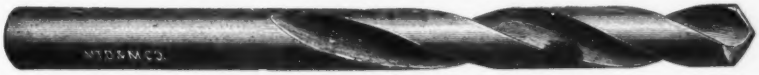

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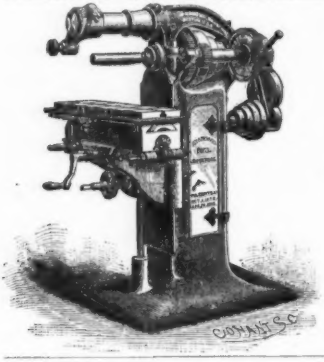

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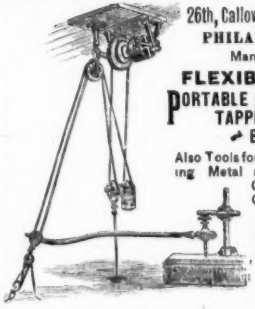

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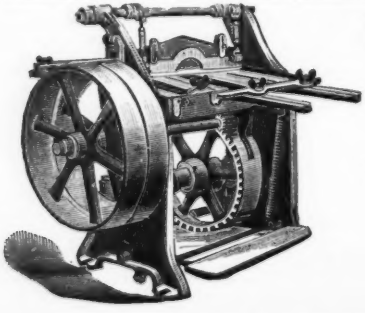

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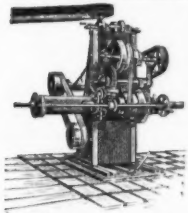

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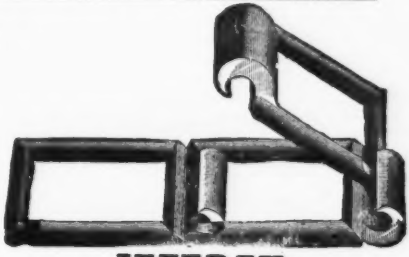

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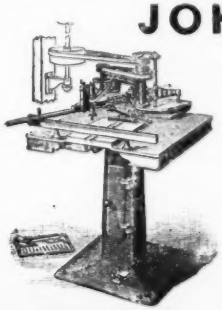

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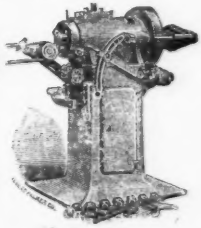

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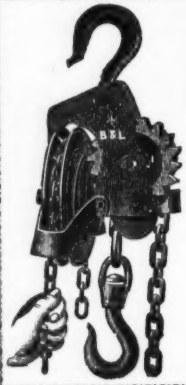

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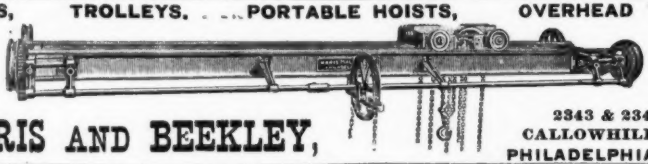

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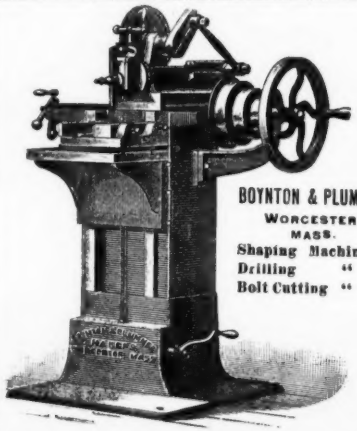

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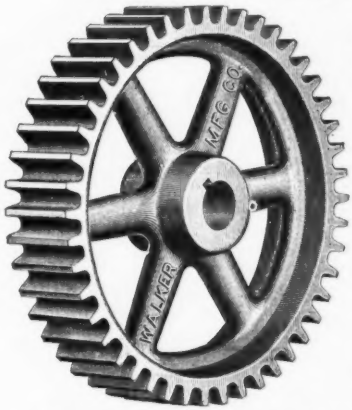

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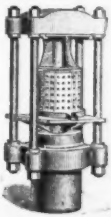

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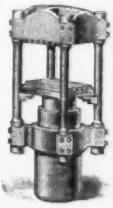

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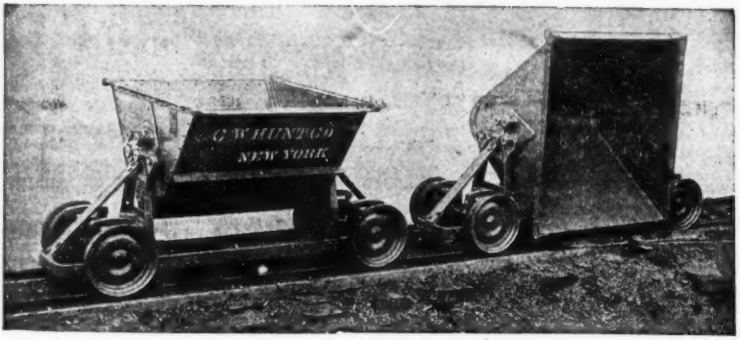

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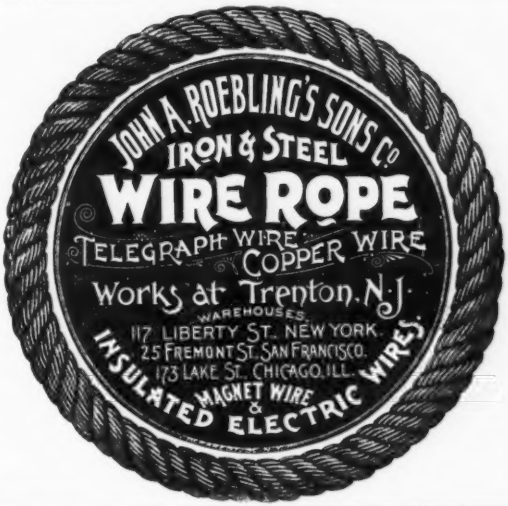

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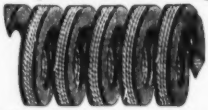
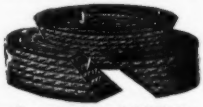

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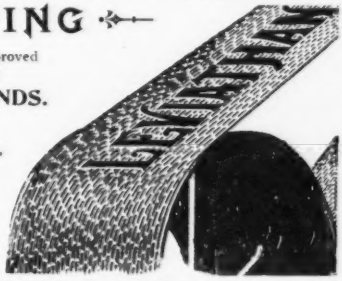

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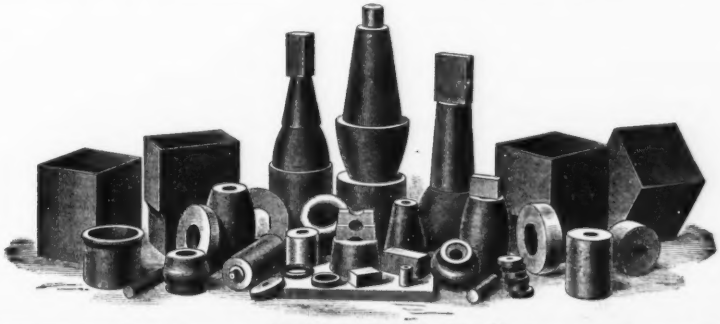

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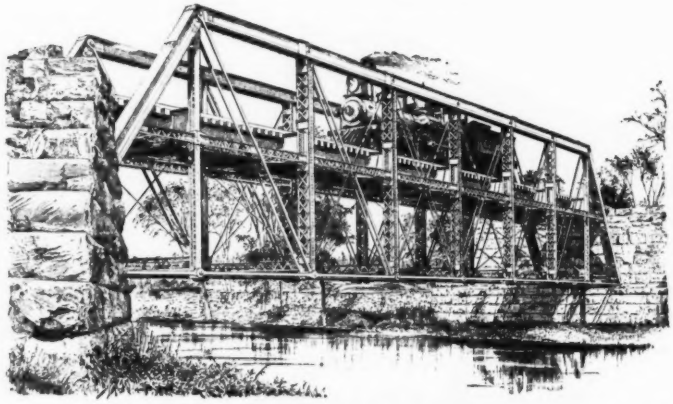

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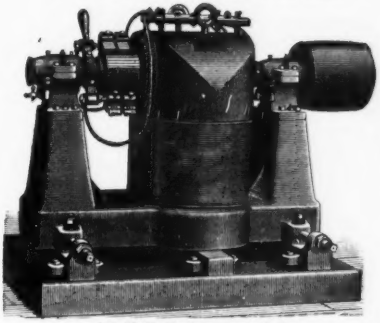

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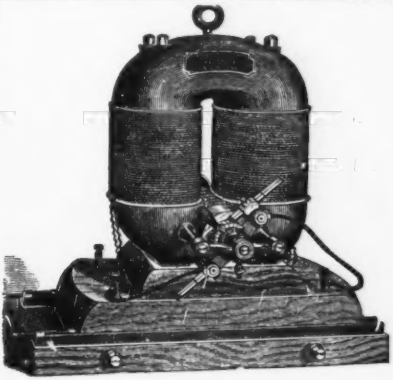

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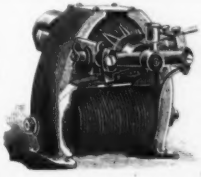

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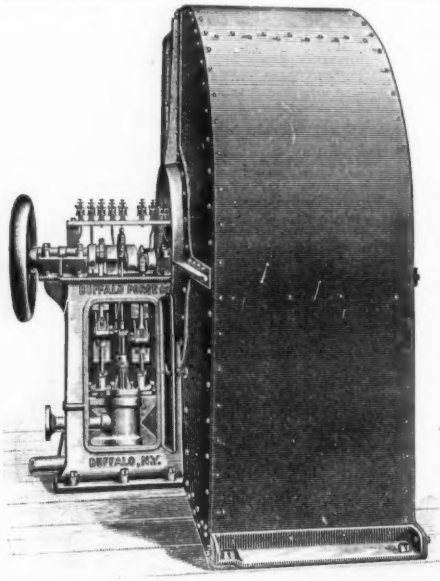

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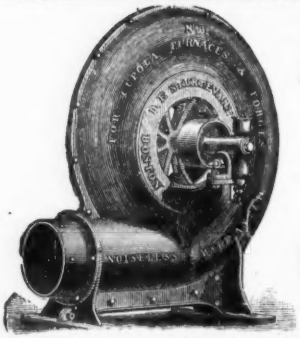

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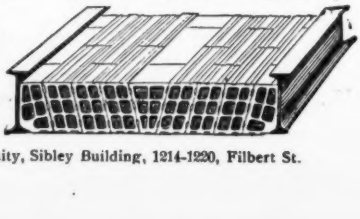

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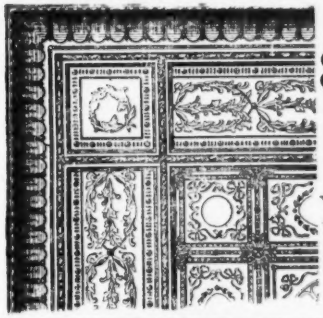

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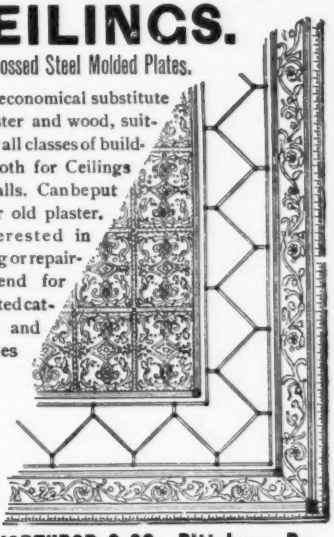

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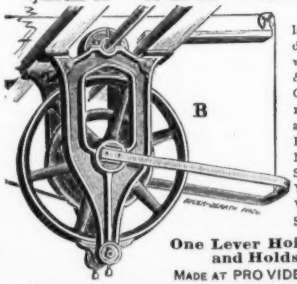

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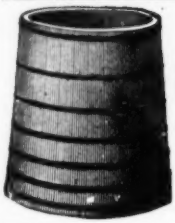

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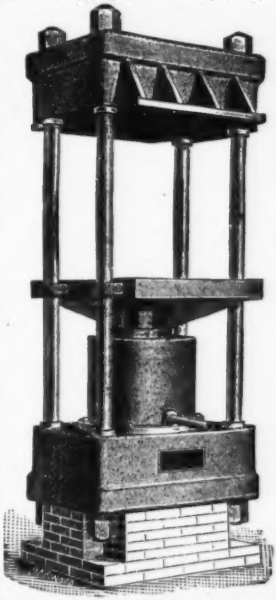

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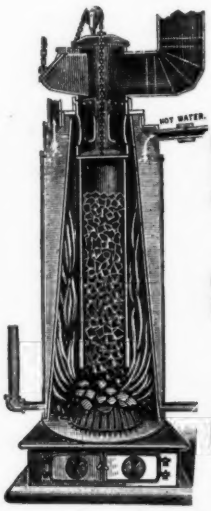

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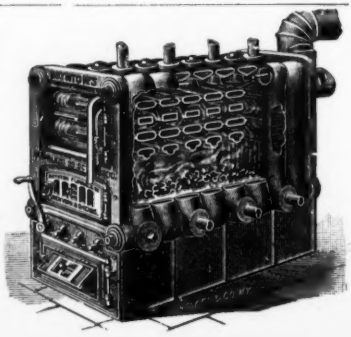

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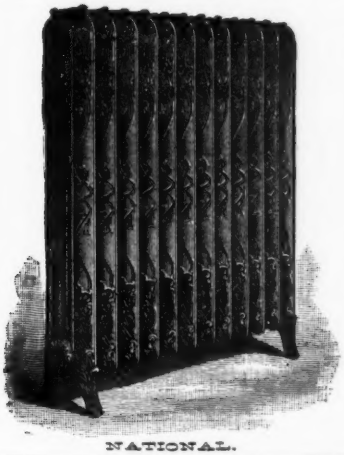

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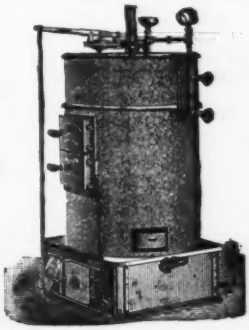

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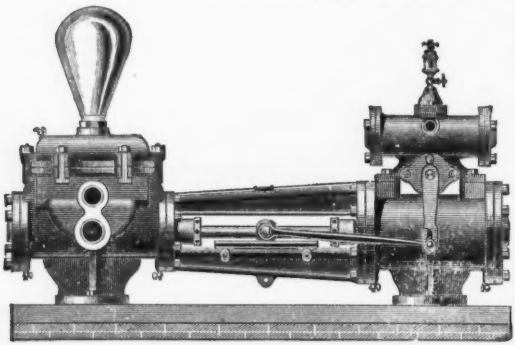

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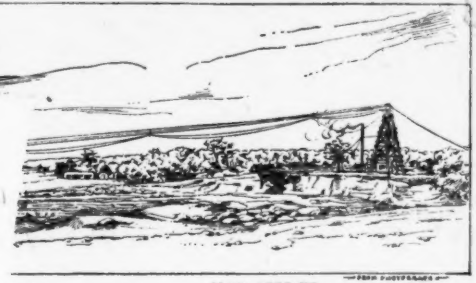

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